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EXPERIMENTAL INQUIRIES

INTO THE

PROPERTIES of the BLOOD.

Lately Publiſhed,

EXPERIMENTAL ENQUIRIES:
PART THE SECOND.
Containing a Deſcription of the
LYMPHATIC SYSTEM,
IN THE
HUMAN SUBJECT,
AND IN OTHER
ANIMALS.
Illuſtrated with PLATES.
By W. HEWSON, F. R. S.
[Price 5s. in Boards.]

Experimental Inquiries:
PART THE FIRST.
CONTAINING AN
INQUIRY
INTO THE
PROPERTIES OF THE BLOOD.
WITH
REMARKS on ſome of its MORBID
APPEARANCES:

AND

AN APPENDIX,

RELATING TO
The Diſcovery of the Lymphatic Syſtem in
Birds, Fiſh, and the Animals called
Amphibious.

The THIRD EDITION.

By WILLIAM HEWSON, F.R.S.
AND TEACHER OF ANATOMY.

Vere ſcire, eſt per cauſas ſcire. Lord BACON.

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TO

Sir JOHN PRINGLE, Bart.

PHYSICIAN TO HER MAJESTY.

SIR,

I Have taken the liberty to addreſs you upon this occaſion, not ſo much that I might pay a compliment to your merit, as that I might boaſt of your friendſhip: It is impoſſible that I ſhould add any thing to your reputation by diſplaying your abilities; but you may add greatly to mine, even by detecting my miſtakes. You have done me the honour to approve this little Eſſay, and I am ambitious to tell the world, that it owes much both to your knowledge and your kindneſs; which have concurred to ſuggeſt many uſeful hints and judicious corrections, that make it more worthy of attention, and afford me a public opportunity of aſſuring you that I am, with the trueſt reſpect and eſteem,

SIR,

Your moſt obedient,
and moſt obliged
humble ſervant,

WILLIAM HEWSON.

PREFACE.

THE knowledge of the human frame, the preſervation of health, and the cure of diſeaſes, are objects of too great importance to mankind, for the Author of theſe ſheets to doubt, that any attempts to promote them, how ſmall ſoever, ſhould not meet with a candid and indulgent reception from the Public. An Inquiry into the Properties of the Blood, it is preſumed, will be thought, in a particular manner, intereſting, ſince there is no part of the human body upon which more phyſiological reaſoning is founded, nor any from which more inferences are drawn for the cure of diſeaſes. And, as the inquiry is made by experiments upon the blood as near as poſſible to the ſtate in which it circulates in the veſſels, it is hoped that the concluſions made from them will ſtand the teſt of a candid examination, and lead to further obſervations and improvements.

Since the publication of the firſt Edition, ſome new experiments have been made, and a new chapter has been added, which contains a recapitulation of the principal facts and concluſions that are met with in this Eſſay. Theſe additions are between p. 98 and 140.

The Appendix is a vindication of the Author's right to the diſcovery of the Lymphatic Veſſels, in oppoſition to the claim of the learned Dr. Alexander Monro, Profeſſor of Anatomy in the Univerſity of Edinburgh.

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AN EXPERIMENTAL INQUIRY INTO THE PROPERTIES of the BLOOD.

CHAP. I.

Of the ſeparation of the Serum; *the colour of the* Craſſamentum; *and of the cauſes of the* COAGULATION OF THE BLOOD.

WHEN freſh blood is received into a baſon, and ſuffered to reſt, in a few minntes it jellies, or coagulates, and ſoon after ſeparates into two parts, diſtinguiſhed by the names of *Craſſamentum* and *Serum*. Theſe two parts differ in their proportions in different conſtitutions; in a ſtrong perſon, the *craſſamentum* is in greater proportion to the *ſerum* than in a weak one; and the ſame difference is found to take place in diſeaſes; thence is deduced the general concluſion, that the leſs the quantity of *ſerum* is in proportion to the *craſſamentum*, bleeding, diluting liquors, and a low diet, are the more neceſſary; whilſt in ſome dropſies, and other diſeaſes where the *ſerum* is in a great, and the *craſſamentum* in a ſmall proportion, bleeding and diluting would be highly improper. As it is therefore ſuppoſed uſeful to attend to the proportions of theſe parts in many diſorders, and even to take indications of cure from them, it has been an object with thoſe who have made experiments on the blood, to determine the circumſtances on which its more perfect ſeparation into theſe two parts depends; it being obvious, that till this be done, our inferences from their proportions will be liable to conſiderable fallacies. Two of the lateſt writers on this ſubject agree, that if the blood, after being taken from a vein, be ſet in a cold place, it will not eaſily ſeparate, and that a moderate warmth is neceſſary: this is a fact that is evinced by daily experience. They likewiſe ſay, that the heat ſhould be leſs than that of the animal, or than 98° of Fahrenheit's thermometer; and that, if freſh blood be received into a cup, and that cup put into water heated to 98°, it will not ſeparate; nay, they even ſay, that it will not coagulate; but this, I am perſuaded from experiments, is ill founded.

EXPERIMENT I.

A TIN-VESSEL, containing water, was placed upon a lamp, which kept the water in a heat that varied betweeen 100 and 105 degrees. In this water was placed a phial, containing blood that inſtant taken from the arm of a perſon in health; the phial was previouſly warmed, then filled, and corked to exclude air. In the ſame water was placed a tea-cup half full of blood, juſt taken from the ſame perſon; a third portion of the blood was then received from the ſame vein into a baſon, and was ſet upon a table, the heat of the atmoſphere being at 67°. Now, according to their opinion, the two former ſhould neither have coagulated nor ſeparated, when that in the baſon began to ſeparate; but, on the contrary, they were all three found to coagulate nearly in the ſame time; and thoſe in the warm water not only did ſeparate as well as the other, but even ſooner.

EXPERIMENT II.

THE ſame experiment was repeated on the blood of a perſon that laboured under the acute rheumatiſm, whilſt the heat of the atmoſphere was no higher than 55°, and that of the warm water was 108°;

and the reſult of this experiment was not only a confirmation of what was obſerved in the firſt, but it even ſhewed, that this degree of heat was ſo far from leſſening, that it increaſed the diſpoſition to coagulate; for the blood in the cup and in the phial was not only congealed, but the ſeparation was much advanced before the whole of the blood in the baſon was coagulated. Thence I am led to conclude, that the ſeparation of the blood in a given time, is in proportion as the heat in which it ſtands is nearer to the animal heat, or 98°; or greater in that heat than in any of a leſs degree. And I am confirmed in this inference by experiments hereafter to be related, where the blood in the living animal, whilſt at reſt, was found bothto coagulate and to ſeparate.

It is well known, that the *craſſamentum* conſiſts of two parts, of which one gives it ſolidity, and is by ſome called the fibrous part of the blood, or the *gluten*, but by others with more propriety termed the *coagulable lymph*; and of another, which gives the red colour to the blood, and is called the *red globules*. Theſe two parts can be ſeparated by waſhing the *craſſamentum* in water, the red particles diſſolving in the water, whilſt the coagulable lymph remains ſolid. That it is the coagulable lymph, which, by its becoming ſolid, gives firmneſs to the *craſſamentum*, is proved by agitating freſh blood with a ſtick, ſo as to collect this ſubſtance on the ſtick, in which caſe the reſt of the blood remains fluid *.

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* It may be proper to mention here, that till of late the coagulable lymph has been confounded with the ſerum of the blood, which contains a ſubſtance that is likewiſe coagulable. But in theſe ſheets, by the *lymph*, is always meant that part of the blood which jellies, or becomes ſolid ſpontaneouſly when blood is received into a baſon, which the coagulable matter that is diſſolved in the ſerum does not; but agrees more with the white of an egg, in remaining fluid when expoſed to the air, and coagulating when expoſed to heat, or when mixed with ardent ſpirits, or ſome other chemical ſubſtances.

THE ſurface of the *craſſamentum*, when not covered with a ſize, is in general of a more florid red than the blood was when firſt taken from the vein, whilſt its bottom is of a dark colour, or blackiſh. This floridneſs of the ſurface is juſtly attributed by ſome of the more accurate obſervers to the air, with which it is in contact; for, if the *craſſamentum* be inverted, the colours are changed, at leaſt that which is now become the upper ſurface aſſumes a more florid redneſs. This difference of colour, others have endeavoured to explain from the different proportions of the red particles, or globules as they are called, which, ſay they, being in a greater proportion at the bottom of the *craſſamentum*, make it appear black; but, if inverted, the globules then ſettle from the ſurface which is now uppermoſt, and that becomes redder. But this I think is not probable; for the lymph in the *craſſamentum* is ſo firmly coagulated, as to make it too denſe to allow of bodies even heavier than the red particles to gravitate through it; for example gold. That air has the power of changing the colour of the blood, has been long known; and the following experiment ſhews it very ſatisfactorily, and hardly leaves room to refer the appearance to another cauſe.

EXPERIMENT III.

Having laid bare the jugular vein of a living rabbit, I tied it up in three places; then opening it between two of the ligatures, I let out the blood, and filled this part of the vein with air. After letting it reſt a little, till the air ſhould become warm, I took off the ligature which ſeparated the air from the blood, and then gently mixed them, and I obſerved that the venous blood aſſumed a more florid redneſs, where it was in contact with the air-bubbles, whilſt in other parts it remained of its natural colour.

THERE is a difference between the arterial and venous blood in colour; the former is of a florid red like the ſurface of the *craſſamentum*, the latter is dark or blackiſh like the bottom of the *craſſamentum*. This change in its colour is produced on the blood as it paſſes through the lungs, as we ſee by opening of living animals*; and as a ſimilar change is produced by air applied to blood out of the body, it is preſumed that the air in the lungs is the immediate cauſe of this change; but how it effects it, is not yet determined.

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* That this change is really produced in the lungs, I am perſuaded from experiments, in which I have diſtinctly ſeen the blood of a more florid red in the left auricle, than it was in the right. But ſome authors of the greateſt authority ſay, that they could not obſerve any ſuch difference in a great number of experiments which they made; but this I ſhould attribute to their having been later in opening the left auricle after the collapſing of the lungs than I was; for it ſeems probable, that whatever is the alteration produced on the blood in its circulation through this organ, that change cannot take place after it is collapſed.

As the blood is changed to a more florid red in paſſing through the lungs, or from the venous to the arterial ſyſtem, ſo it loſes that colour again in paſſing from the arteries to the veins in the extreme parts, eſpecially when the perſon is in health; but every now and then we obſerve the blood in the veins more florid than is uſual, and it likewiſe frequently happens in veneſection, that the blood which comes firſt out is blackiſh, and that which comes afterwards is more florid: in ſuch caſes the arterial blood paſſes into the veins without undergoing that change which is natural to it.

SOME of the neutral ſalts have a ſimilar effect on the colour of the blood to what air has, particularly nitre; thence ſome have attributed the difference of colour in the arterial and venous blood to nitre, which they ſuppoſed was abſorbed from the air whilſt in the lungs. But we know that this is a mere hypotheſis, for air contains no nitre. Indeed nitre is far from being the only neutral ſalt which has this effect on the blood, for moſt of them have ſome degree of it. In making ſome experiments on this ſubject, I have obſerved a more remarkable effect which ſome of the neutral ſalts have upon the blood; and that is, being mixed with it when juſt received from the vein, they prevent its coagulation, or keep it fluid, and yet, upon adding water to the mixture, it then jellies or coagulates. Thus, if ſix ounces of human blood be received from a vein upon half an ounce of true Glauber's ſalt reduced to a powder, and the mixture agitated ſo as to make the ſalt be diſſolved, that blood will not coagulate on being expoſed to the air, as it would have done without the ſalt; but if to this mixture about twice its quantity of water be added, in a ſhort time the whole will be jellied or coagulated, and on ſhaking the jelly, the *coagulum* will be broken, and the part ſo coagulated can be now ſeparated as it falls to the bottom, and proves to be the lymph.

In theſe mixtures of the blood with neutral ſalts, the red particles readily ſubſide, (eſpecially if human blood be uſed) and the ſurface of the mixture becomes clear and colourleſs; and being poured off from the red part, it is found to contain the coagulable lymph, which can be ſeparated by the addition of water.

I have tried moſt of the neutral ſalts, and have made a table of their effects on the blood; but it is not neceſſary to trouble the reader with it, as we do not ſee of what uſe it could be in medicine; for we muſt not conclude that their effects within the body would be the ſame as out of it *. Indeed, theſe experiments,

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* The ſalts which keep the blood fluid by itſelf, and yet allow it afterwards to jelly on being mixed with water, are, *Sal Glauberi verus*; *Sal Digeſtivus Sylvii*,

periments, as well as ſome others, were not made ſo much with a view of any immediate application to medicine, as to determine the properties of the blood chemically; for, having ſet out with a perſuaſion, that a more particular acquaintance with the properties of this fluid was neceſſary before we could arrive at the knowledge of ſome of the animal functions, ſuch as the manner in which the bile and other ſecreted fluids are formed, I therefore was anxious to throw ſome more light on this ſubject. With this view I have made ſome experiments even on living animals, being convinced that

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Sylvii; *Sal Communis*; *Nitrum Commune*;—— *Nitrum Cubicum*; *Sal Diureticus*; *Borax.* The ſalt made of vinegar and the foſſile Alkali; and the ſalt made with Vinegar and Chalk.

The following ſalts likewiſe keep the blood fluid, but do not allow it to jelly when mixed with water; *Tartarus Vitriolatus*; *Sal Epſomenſis*; *Sal Ammoniacus Communis*; *Sal Ammoniacus Nitroſus*; *Sal Rupillenſis.*

But Alum on being mixed with blood coagulates it immediately.

that my inquiries would not otherwiſe be ſatisfactory.

When blood is thus kept fluid by Glauber's ſalt, it ſtill retains its property of being coagulable by heat, and by other ſubſtances as before, air excepted. This method of keeping the blood fluid may therefore be uſeful, by affording an opportunity of making ſome experiments upon it, which we could not otherwiſe do from its coagulating ſo ſoon when taken from the veſſels.

This property of one of the neutral ſalts has been long known amongſt thoſe who prepare the blood of cattle for food; for it has long been a practice with ſuch people, to receive it into a veſſel containing ſome common ſalt, and to agitate it as faſt as it falls, by which means the coagulation is prevented, and the blood remains ſo fluid as to paſs through a ſtrainer, without leaving any *coagulum* behind: by this means they have an opportunity of mixing it with other ſubſtances for culinary purpoſes

ALTHOUGH the coagulable lymph ſo readily becomes ſolid when expoſed to the air, yet whilſt circulating it is far from that conſiſtence: it has indeed been ſuppoſed to be fibrous, even whilſt moving in the blood-veſſels, but erroneouſly.

IT is this coagulable lymph which forms the inflammatory cruſt, or *buff*, as it is called, It likewiſe forms *polypi* of the heart, and ſometimes fills up the cavities of aneuriſms, and plugs up the extremities of divided arteries. It is ſuppoſed, by its becoming ſolid in the body, to occaſion obſtructions and inflammations; and even mortifications, from the expoſition to cold, have been attributed to its coagulation. In a word, this lymph is ſuppoſed to have ſo great a ſhare in the cauſe of ſeveral diſeaſes, that it would be a deſirable matter to be able to aſcertain the cauſes of that coagulation, either in the body, or out of it.

THE blood, when received into a baſon, and ſuffered to reſt in the common heat of the atmoſphere, very ſoon jellies or coagulates; the part which now becomes ſolid is the coagulable lymph, as has been ſhewn above. The circumſtances in which it now differs from what it was in the veins, are theſe: it is expoſed to the air, to cold, and is at reſt; for whilſt in the body, air is excluded, it is there of a conſiderable warmth, and is always in motion. The queſtion is, to which of theſe circumſtances its coagulation whilſt in the baſon is chiefly owing. This queſtion, I believe, cannot well be anſwered from the experiments that have hitherto been made. It has indeed been ſaid, that the cold alone coagulated it; for, ſay they, if you receive blood into a baſon, and ſet that baſon in warm water, and ſtir the blood well, it can be kept fluid. But in the experiments from which this concluſion was made, I find there has been a deception *. In ſhort, I have found that it coagulates as ſoon when kept warm and when agitated, as it does when ſuffered to reſt and to cool. As the ſubject ſeemed to me of importance, I have endeavoured to aſcertain the circumſtance to which this coagulation is owing by ſeveral experiments, in each of which the blood was generally expoſed to but one of the ſuſpected cauſes at a time. Thus, in order to ſee whether the blood's coagulation out of the body was owing to its being at reſt, I made the following experiment:

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* That is, the lymph really had been coagulated, but by the agitation had likewiſe been ſeparated from the reſt of the blood, and had thereby eſcaped notice.

EXPERIMENT IV.

HAVING laid bare the jugular vein of a living dog, I made a ligature upon it in two places, ſo that the blood was at reſt between the ligatures; then covering the vein with the ſkin, to prevent its cooling, I left it in this ſituation. From ſeveral experiments made in this way, I found in general, that after being at reſt for ten minutes, the blood continued fluid; nay, that after being at reſt for three hours and a quarter, above two-thirds of it were ſtill fluid, though it coagulated afterwards. Now the blood, when taken from a vein of the ſame animal, was completely jellied in about ſeven minutes. The coagulation therefore of the blood in the baſon, and of that which is merely at reſt, are ſo different, that reſt alone cannot be ſuppoſed to be the cauſe of the coagulation out of the body.

To ſee the effects of cold on the blood, I made this experiment:

EXPERIMENT V.

I KILLED a rabbit, and immediately cut out one of its jugular veins, proper ligatures being previouſly made upon it; I then threw the vein into a ſolution of ſal ammoniac and ſnow, in which the mercury ſtood at the 14th degree of Fahrenheit's thermometer. As ſoon as the blood was frozen and converted into ice, I took the vein out again, and put it into lukewarm water till it thawed and became ſoft; I then opened the vein, received the blood into a tea-cup, and obſerved that it was perfectly fluid, and in a few minutes it jellied or coagulated, as blood uſually does. Now, as in this experiment the blood was frozen and thawed again without being coagulated, it is evident that the coagulation of the blood out of the body is not ſolely owing to cold, any more than it is to reſt.

NEXT, to ſee the effects of air upon the blood, I tried as follows:

EXPERIMENT VI.

HAVING laid bare the jugular vein of a living rabbit, I tied it up in three places, and then opened it between two of the ligatures, and emptied that part of its blood. I next blew warm air into the empty vein, and put another ligature upon it, and letting it reſt till I thought the air had acquired the ſame degree of heat as the blood, I then removed the intermediate ligature, and mixed the air with the blood. The air immediately made the blood florid, where it was in contact with it, as could be ſeen through the coats of the vein. In a quarter of an hour I opened the vein, and found the blood entirely coagulated; and as the blood could not in this time have been completely congealed by reſt alone, the air was probably the cauſe of its coagulation.

FROM comparing theſe experiments, may we not venture to conclude, that the air is a ſtrong coagulant of the blood, and that to this its coagulation when taken from the veins is chiefly owing, and not to cold, nor to reſt?

BUT although it appears from theſe experiments, that the coagulation of the blood in the baſon is owing to the air alone; for cold has no ſuch effect, nor has reſt in a ſufficient degree, becauſe the coagulation of the blood in the baſon takes place in a few minutes, whilſt that which is merely at reſt in the veins is not completely coagulated in three hours or more. Yet the blood is in time completely coagulated merely by its being at reſt in the veins; but then in this caſe it coagulates in a different manner from what it does in the baſon; and as it probably is in this way that the blood is coagulated in the body, I have been more particularly attentive to it, and have endeavoured to determine by experiment how it takes place. With this view I have ſeveral times repeated Experiment the 4th, which was made with a view to determine whether the blood would coagulate by reſt. In the firſt trial, the vein was not opened till the end of three hours and a quarter; and juſt before it was opened I had obſerved through its coats, that the upper part of the blood was tranſparent, owing to the ſeparation of the lymph. On letting out this blood, it ſeemed to me entirely fluid: a part indeed had been loſt, but the greateſt part was collected in the cup, and which afterwards coagulated as blood commonly does when expoſed to the air. From this experiment I imagined that the whole had been fluid; but from others made ſince, I am perſuaded that the part which was loſt had been coagulated; for, from a variety of trials, I now find, that though the whole of the blood is not congealed in this time by reſt alone, yet a part of it is. But as it would be treſpaſſing too much on the reader's time to relate every experiment I have been obliged to make for this purpoſe, I ſhall only mention the general reſult of the whole.

After fixing a dog down to a table, and tying up his jugular veins, I have in general found, that on opening them at the end of ten minutes, the blood was ſtill entirely fluid, or without any appearance of coagulation *. If they were opened at the end of fifteen minutes, at firſt ſight it alſo appeared quite fluid; but on a careful examination I found ſometimes one, and ſometimes two or three ſmall particles about the ſize of a pin's head, which were coagulated parts of the blood. When opened later than this period, a larger and larger

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* I ſay *in general* it was fluid at the end of ten minutes; but I muſt likewiſe mention that in one dog I found two very ſmall particles of beginning coagulation, even at this period; yet in another I could not obſerve any ſuch appearance, even at the end of fifteen minutes.

coagulum was obſerved; but ſo very ſlowly does this coagulation proceed, that in an experiment where I had the curioſity to compare more exactly the clotted part with the unclotted, I found, after the vein had been tied two hours and a quarter, that the *coagulum* weighed only two grains; whilſt the reſt of the blood, which was fluid, on being ſuffered to congeal, weighed eleven grains. I can advance nothing farther in this part of my ſubject with preciſion. Nor can I pretend exactly to determine the time at which all the blood between the ligatures is coagulated. I have indeed opened ſuch a vein at the end of three days, when I found a thin, white *coagulum*, which was a mere film; the *ſerum* and red particles having diſappeared. But the whole is undoubtedly congealed long before this period. The manner in which the blood coagulates, when at reſt in the body, has appeared to me curious, and therefore I have taken the more pains to diſcover how it happens, eſpecially as it may aſſiſt us in judging whether or no it coagulates in the heart, ſo as to form thoſe ſubſtances called *polypi.* The abovementioned times will, I believe, be found to be thoſe at which the blood congeals in the veins of healthy dogs: and as I have found, by experiments, that the blood of a dog and of the human ſubject in health jellies out of the body, nearly in the ſame time, that is, it begins in three or four minutes, and is completed in ſeven or eight; I ſhould therefore conclude that the blood in the veins of the human body coagulates nearly at the ſame period with that of a dog. But it may be neceſſary to add here, that from experiments which I have made, I have reaſon to believe that the time at which the blood coagulates, is different in different conſtitutions, and in different diſeaſes. For though the blood of a perſon in health is completely coagulated in ſeven minutes after it is taken out of the veins, yet in ſome diſeaſes, I have found the blood fifteen or twenty minutes, nay even an hour and an half, before it was completely jellied.

As we ſee in the above-related experiments, that the blood coagulates in the body when ſuffered to reſt for a little time, is it not probable that to this cauſe its coagulation in thoſe true aneuryſms, which are attended with a pouch, are owing*? For in ſuch enlargements a part of the blood is without motion, which will congeal when at reſt, and in contact with the ſack; and thus one layer may be formed; and the ſack afterwards enlarging, another portion of the blood will then be at reſt; and ſo a ſecond layer may be formed; and thence probably is the origin of thoſe laminated *coagula* met with in ſuch ſacks.

LIKEWISE, to the blood's being at reſt, is probably owing its coagulation in the large arteries which are tied after amputation, or other operations; for after moſt of ſuch ligatures there will be a part of the artery impervious, in which the blood can have no motion. The *coagulum* after amputation might indeed be ſuppoſed owing to air; but, conſidering the manner in which arteries are tied whilſt the blood is running from them, it does not ſeem probable that the air has any effect on what is above the ligature.

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* An inſtance of which may be ſeen in the Med. Obſ. and Inq. vol. i. article xxvii. fig. iii.

To the blood's being without motion in the cavity of the *uterus*, is its coagulation therein probably owing; hence the origin of thoſe large clots which ſometimes come from that cavity; and which, when more condenſed by the oozing out of the *ſerum*, and of the red globules, aſſume a fleſh-like appearance, and have often been called *Moles* or *falſe conceptions*.

In Experiment the 5th, we found that the blood could be frozen and thawed again, without being coagulated: this likewiſe is an experiment which I have repeated ſeveral times, that I might be ſure of the fact. I have alſo varied the experiment by ſometimes putting the vein into a phial of water, and freezing the whole in a ſolution of ſal ammoniac in ſnow; and ſometimes I have put the vein into the ſolution itſelf; and three or four times I have thrown it into oil, and then frozen it; but after all theſe trials the reſult was the ſame. The blood was always evidently fluid on being thawed, and as evidently jellied when expoſed to the air.

Besides being coagulated when expoſed to the air, the coagulable lymph, as well as the *ſerum*, is known to be fixed by heat; but the degree of heat has not, ſo far as I know, been determined. It has been ſuppoſed to require a degree almoſt equal to that which coagulates the *ſerum* * but one much leſs is neceſſary, as will appear from the following experiments.

EXPERIMENT VII.

Having found, from a number of trials, that blood, kept fluid by means of true Glauber's ſalt, had its lymph coagulated by a heat of 125° of Fahrenheit's thermometer, I ſuppoſed that the degree neceſſary for fixing it in its natural ſtate could not be very different from this. I therefore prepared a lamp-furnace with a ſmall veſſel of water upon it; this water was heated to 125°; and then laying bare the jugular vein of a living dog, I tied it properly, cut a piece of it out, and put it into this water: after eleven minutes, I took out the vein, opened it, and found the blood entirely coagulated; thence I concluded, that 125°, or leſs, was ſufficient to coagulate the blood of a dog. It may be neceſſary to obſerve here, that the part coagulated was only the lymph; for the *ſerum* requires a much greater heat to fix it, that is a heat of 160°, as will appear hereafter.

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* See Traité du Cœur. T. ii. p. 93. Schwenke Hæmatolog. p. 138.

EXPERIMENT VIII.

THE ſame experiment was repeated in ſuch a manner, that the heat never went higher than 120° and an half; and I found, that on opening the vein at the end of eleven minutes, the lymph was entirely coagulated, even in this heat.

EXPERIMENT IX.

I REPEATED the experiment with a heat no higher than 114°, and at the end of eleven minutes, the vein being opened, the blood was found to be fluid, and in a few minutes after, being laid open to the air, it coagulated as uſual. Now, as the blood in the laſt experiment was coagulated, when the heat had never riſen above 120° and an half; and in this experiment was fluid, though it had been expoſed to a heat of 114°; we may therefore conclude, that the coagulable lymph in the blood of a dog, in health, is fixed in a degree of heat between 114° and 120°½ of Fahrenheit's thermometer.

As to the degree of heat at which the lymph in human blood coagulates, I have not yet had an opportunity of trying it in a more ſatisfactory way, than with the mixture with Glauber's ſalt, in which ſtate it coagulates at 125°. But, as we find that the human blood and that of a dog jelly nearly in the ſame time, when expoſed to the air, I think it probable that the preciſe degree of heat at which the lymph of the human blood coagulates, is between 114° and 120°½. I have thought of making the experiment on the umbilical cord of a recent *placenta*, which perhaps is the moſt likely way of coming at the truth.

The degree of heat, at which the *ſerum* of the blood (which ſhould not be confounded with the lymph) coagulates, is generally ſaid to be 150°; but from my experiments I am inclined to believe it requires a greater heat to fix it. They were made in the following manner:

EXPERIMENT X.

I took a wide-mouthed phial, containing ſome *ſerum*, and placing a thermometer in it, I put it into water which was kept warm by a lamp underneath; and, in making this experiment with as much accuracy as I could, I found the heat required was 160°; which is about forty degrees more than is neceſſary for the coagulation of the lymph.

As the blood is coagulable by heat, and as the heat of an animal is increaſed in fevers, it has been ſuppoſed that the blood might be coagulated by the animal heat, even whilſt it is circulating in the veſſels; but there is little foundation for ſuch an opinion, ſince the animal heat is naturally only 98° or 100°, and in the moſt ardent fever is not raiſed above 112°.

CHAP. II.

Of the inflammatory Cruſt, or Size.

I SHALL next proceed to inquire into the formation of the inflammatory cruſt, or *ſize*, as it is called.

THIS remarkable appearance is frequently met with in inflammatory diſorders, and is formed by the coagulable lymph's being fixed, or coagulated, after the red particles have ſubſided. It has indeed been ſuppoſed to be formed from the *ſerum* of the blood; and an excellent writer on this ſubject ſeems in doubt to which of the two it ſhould be attributed. But that it is formed by the coagulable lymph alone, after the red particles have ſubſided, appears from the following experiments.

EXPERIMENT XI.

In the month of June, when the thermometer in the ſhade ſtood at 67°, I bled a man who had laboured under a *phthiſis pulmonalis* for ſome months, and at that time complained of a pain in his ſide. The blood, though it came out in a ſmall ſtream, yet flowed with ſuch velocity, that it ſoon filled the baſon. After tying up his arm I attended to the blood, and obſerved that the ſurface became tranſparent, and that the tranſparency gradually went deeper and deeper, the blood being ſtill fluid. I likewiſe obſerved that the coagulation firſt began on the ſurface, where it was in contact with the air, and formed a thin pellicle; this I removed, and ſaw that it was ſoon ſucceeded by a ſecond. I then took up a part of the clear liquor with a wet tea-ſpoon, and put it into a phial with an equal quantity of water; a ſecond portion

I kept in the tea-ſpoon; and I found afterwards that they both jellied or coagulated, as did alſo the ſurface of the *craſſamentum*, making a thick cruſt. On preſſing with my finger that portion which was in the tea-ſpoon, I found it contained a little *ſerum.*

From this experiment it is evident, that the ſubſtance which formed the ſize was fluid after it was taken from the vein, and coagulated when expoſed to the air; and as this is a property of the coagulable lymph alone, and not of the *ſerum*, there can be no doubt that the ſize was formed of the lymph.

The following experiment, made on the blood, without expoſing it to the air, likewiſe proves the ſame fact.

EXPERIMENT XII.

IMMEDIATELY after killing a dog, I tied up his jugular veins near the *ſternum*, and hung his head over the edge of the table, ſo that the parts of the veins where the ligatures were might be higher than his head. I looked at the veins from time to time, and obſerved that they became tranſparent at their upper part, the red particles ſubſiding. I then made a ligature upon one vein, ſo as to divide the tranſparent from the red portion of the blood; and opening the vein, I let out the tranſparent portion, which was ſtill fluid, but coagulated ſoon after. On preſſing this *coagulum*, I found it contain a little *ſerum*. The other vein I did not open till after the blood was congealed, and then I found the upperpart of the *coagulum* whitiſh like the cruſt in pleuritic blood*.

And that the ſize is merely the coagulable lymph ſeparated by the ſubſidence of the red particles, will appear evident to any perſon who will, as Sydenham directs, move a finger, or a tea-ſpoon through the blood when he obſerves its ſurface becoming tranſparent; for in this caſe the blood that otherwiſe would have been ſizy, will now have a natural appearance, or be without ſize; from the red particles being prevented from ſubſiding.

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* This is not the only apparently healthful animal whoſe blood had a cruſt; I have ſeen it in others: whence I at firſt ſuſpected that merely keeping the blood fluid for a little time was ſufficient to produce this appearance; but I altered my opinion, on ſeeing, that in the greateſt number of animals it did not occur: nor is it commonly met with in the hearts of thoſe perſons who die a violent death, though the blood remains longer fluid in ſuch caſes, than it does in the baſon where the ſize appears.

It has been a very generally received opinion, that inflammation thickens the blood, and makes it more ready to coagulate. Nay, ſome have gone ſo far as to ſay, that in thoſe diſorders where the inflammatory cruſt is ſeen, the blood is almoſt coagulated even before it is let out of the vein. Now I am perſuaded from experiment, that the contrary of this is true; or that inflammation, inſtead of increaſing the diſpoſition of the blood to coagulate, really leſſens it; and inſtead of thickening the blood, really thins it; at leaſt that part which forms the cruſt, viz. the coagulable lymph.

In the firſt place, that inflammation really leſſens the diſpoſition to coagulate, will appear evident to every one who attends to the jellying of ſuch blood as has a cruſt. For in all thoſe caſes the blood will be found to be longer in congealing, than in its natural ſtate. To this opinion I was firſt led by attending to the phthiſical patient's blood abovementioned; but

I have ſince made a compariſon, which ſeems to prove the fact. For, from a variety of experiments made on the blood of perſons nearly in health, or at leaſt who had no inflammatory diſorder, and no cruſt on their blood, I found that after being taken from a vein, it began to jelly in about three minutes and an half. The firſt appearance of coagulation was a thin film on the ſurface near the air-bubbles, or near the edge of the baſon; this film ſpread over the ſurface, and thickened gradually till the whole was jellied, which was in about ſeven minutes after the opening of the vein; and in about ten or eleven the whole was ſo firm, that, on cutting the cake, the gaſhes were immediately filled up by the *ſerum*, which now began to ſeparate from the *craſſamentum*. But in thoſe perſons whoſe blood had an inflammatory cruſt, the coagulation was much later; as will appear from the following experiments.

EXPERIMENT XIII.

I BLED a woman who was ſeven months gone with child, and the blood was received into a baſon. In five minutes after the vein was opened, a film firſt appeared; but this ſpread ſo ſlowly, that in ten minutes it did not cover the whole ſurface; in fifteen minutes it had nearly ſpread over the ſurface; but the reſt of the blood was quite fluid, at leaſt for ſome depth, and even in half an hour it was not ſo firmly jellied as it was afterwards. In this caſe there was a very thick and ſtrong cruſt or ſize.

EXPERIMENT XIV.

HAVING bled a perſon with a violent rheumatic pain in his breaſt, the blood was received into three tea-cups, and each of them had afterwards a cruſt. In the firſt I obſerved the progreſs of the coagulation, as follows: The beginning of the coagulation was not marked, but at the end of half an hour the film was not thicker than common writing-paper; and this being removed, a little of the clear lymph was taken up with a wet tea-ſpoon, put into a clean cup, and was twenty minutes more in coagulating. Even at the end of an hour and an half, the whole of the blood was not jellied; for at this time I removed the film or pellicle, and took up a ſecond portion of clear lymph with a ſpoon, and put it into a tea-cup, where it jellied afterwards; though this jelly was not indeed quite ſo firm as the *craſſamentum* itſelf

EXPERIMENT XV.

A WOMAN, with a ſlight inflammation in her throat, had eight ounces of blood taken from her arm; the blood was received into a baſon, and the bleeding finiſhed in four minutes and three quarters, when a film began to form near the air-bubbles; in ſeven minutes a tranſparent ſize appeared over a conſiderable part of the ſurface which was quite fluid, whilſt the reſt of the blood was coagulating, there being now a very diſtinct red cruſt over the reſt of the ſurface.

Now, from comparing theſe experiments with what has been obſerved of the coagulation of the blood, where there is no inflammatory cruſt or ſize, is it not evident that the blood remains longer fluid after being expoſed to the air, and has leſs diſpoſition to coagulate, in thoſe caſes where there is a ſize, than where there is none? for where there was none, it was found to coagulate completely in ſeven minutes; but in one of the others, where the ſize was very thick, it did not completely coagulate in leſs than an hour and an half.

THE power that inflammation has in leſſening the diſpoſition of the lymph to coagulate is likewiſe plain from the following experiment, where the blood in the heart of a dead animal ſeems to have congealed very ſlowly.

EXPERIMENT XVI.

A DOG was killed eight hours after receiving a large wound in his neck. The wound had during this time inflamed conſiderably. Upon opening him next morning, when he had been dead thirteen hours, a large whitiſh *polypus*, was found in the right ventricle of his heart; under this was a little blood ſtill fluid, which being taken up with a teaſpoon, coagulated ſoon after being expoſed to the air.

IT may be proper to obſerve here, that in the hearts of animals which had died without any inflammation, I have found the blood entirely coagulated long before this time. And that from opening them at different times, I have ſeen it coagulate in their hearts after death, in the ſame gradual manner that it does in their veins, when its motion is ſtopt by ligatures; as related in page 23.

In the next place, that the blood is really attenuated in inflammatory diſorders, where the whitiſh cruſt or ſize appears, is probable from the following circumſtances: Firſt, It even ſeems thinner to the eye; 2dly, The red particles or globules ſubſide ſooner in ſuch blood, than in that of an animal in health. This ſeems proved by obſerving that in the above-mentioned experiments, where the blood was at reſt in the veins, it was not covered with a cruſt, except in one or two inſtances, though in all thoſe caſes it remained longer fluid than the blood commonly does in a baſon, after bleeding, where the cruſt appears. And again, the blood in the heart of an animal that dies a violent death, is not generally covered with a white cruſt, notwithſtanding it is ſo late in being congealed. Theſe circumſtances ſhew, that ſomething more than merely a leſſened diſpoſition to coagulate is neceſſary for the forming of the cruſt or ſize. 3dly, The globules more readily ſubſide in inflammatory caſes, from the ſurface of the whole maſs of blood, than they will afterwards do from the ſurface of a mixture with the *ſerum* alone, of which the following experiments are a proof. But, before I relate them, let me obſerve, that they were made with a view to diſcover, whether the inflammatory cruſt could be owing to any other cauſe than to the attenuation of the coagulable lymph, and to its diſpoſition to coagulation being leſſened: and as the ſame appearance might be ſuſpected to ariſe from an increaſed ſpecific gravity in the red particles, or from the *ſerum* alone being attenuated, I endeavoured to decide the queſtion in the following manner.

EXPERIMENT XVII.

Into a phial, marked A, I put an ounce of the *ſerum* of the blood of a perſon, whoſe *craſſamentum* had an inflammatory cruſt.

Into another, marked B, I poured an ounce of the *ſerum* of a perſon whoſe blood had no cruſt; then to each of theſe, I added a tea-ſpoonful of *ſerum*, loaded with the red particles of a perſon whoſe blood had no inflammatory cruſt or ſize. In attending to them, I could not obſerve that the red particles ſubſided at all ſooner in the *ſerum* of the blood that had a cruſt, than they did in the *ſerum* of that blood which had no cruſt. Thence I conclude, that the *ſerum* is not attenuated in thoſe caſes where the inflammatory cruſt appears.

LASTLY, To ſee whether the ſpecific gravity of the red globules was increaſed, I proceeded as follows:

EXPERIMENT XVIII.

I POURED into a phial C, a portion of the *ſerum* of the blood which had no cruſt; and likewiſe into another D, a ſecond portion of the ſame *ſerum*. I then added to C a tea-ſpoonful of the ſame *ſerum*, loaded with red particles from the blood which had an inflammatory cruſt. And into D I poured a tea-ſpoonful of the ſame *ſerum*, loaded with the globules of that blood which had no cruſt. In viewing theſe, I could not obſerve, that the globules of the blood which had an inflammatory cruſt ſubſided ſooner than thoſe of the blood which had none: whence I inferred, that the ſpecific gravity of the red particles, or globules as they are called, is not increaſed in thoſe caſes where the cruſt appears. And, therefore, ſince that inflammatory cruſt or ſize ſeems neither owing to the *ſerum*'s being attenuated, nor to an increaſed ſpecific gravity in the red particles, it probably depends ſolely upon a change in the coagulable lymph. And what ſeems farther to confirm this inference, in none of theſe experiments did the red particles ſubſide from the ſurface of the *ſerum* in 20 minutes, though, where the cruſt appears, they ſubſide from the ſurface of the blood in half that time; ſo that the whole maſs of blood ſeems to be thinner than the *ſerum* alone; or, the coagulable lymph ſeems to be ſo much attenuated in theſe caſes, as even to dilute the *ſerum*, which at firſt ſight appears a paradox.

MAY we not, therefore, conclude, that in thoſe caſes where the inflammatory cruſt appears, the coagulable lymph is thinner, and its diſpoſition to coagulation is leſſened? both of which circumſtances contribute to the ſubſiding of the red globules from the ſurface of the blood, which then coagulating gives riſe to this appearance, called the inflammatory cruſt or ſize, in the blood of pleuritic or rheumatic patients *.

How contrary to the concluſion, which theſe experiments lead us to, are the opinions of ſome medical writers on this ſubject! How frequently do we find it ſaid, that the blood is thicker in inflammatory diſorders, where that ſize occurs; and that a larger orifice is neceſſary to let out the vitiated blood! That a large orifice is preferable to a ſmall one in many caſes, where ſuch blood is found, I believe to be true; but that its advantages are owing to its letting out the thickened blood, ſeems improbable from what we have

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* This remarkable appearance might indeed be accounted for, by ſuppoſing that the lymph had aſcended to the ſurface of the blood in thoſe caſes; but this is improbable, from conſidering, that, in its coagulated ſtate, it is of greater ſpecific gravity than the ſerum, and ſinks in it.

have ſeen in the experiments above related; they are perhaps nearer the truth, who attribute it to the ſuddenneſs of the evacuation.

It may be proper to obſerve here, that this ſize or whitiſh cruſt is not a certain ſign of inflammation; it being often met with where there ſeems to be no ſuch diſeaſe, in particular in the blood of pregnant women. And that it differs much in denſity in different caſes; in ſome it is extremely firm, in others it is ſpungy or cellular, and contains much *ſerum* in its cells. Theſe diverſities we ſhall endeavour to explain hereafter, when we have laid before the reader ſome more obſervations on the coagulation of the lymph †.

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† Although this Eſſay has been ſo lately printed, yet moſt of the facts which occur in the preceding pages have been mentioned in my Anatomical Lectures, ever ſince the year 1767; and ſome of them were mentioned publicly even before that time. This I thought neceſſary to obſerve, becauſe many of them have ſince appeared in other publications.

CHAP. III.

Of the cauſes of the inflammatory cruſt's appearing at different times in blood-letting; of the ſtopping of hemorrhages; and of the effects of cold upon the blood.

IT has been obſerved by thoſe who have written on the blood, that it ſometimes happens in blood-letting, that the firſt cup has an inflammatory cruſt, whilſt the laſt has none; but no ſatisfactory reaſon has been given for this difference. One might ſuppoſe that it was owing to ſome circumſtance in the bleeding, ſuch as in the different velocity with which the blood flowed into each cup, or to the laſt cup's being agitated ſo as to prevent the ſeparation of the lymph: but I have ſeen it where there was no difference of this ſort, nor in any other circumſtance that I could obſerve. I therefore ſuſpect that in ſuch caſes the properties of the blood are changed, even during the time of the evacuation; to which opinion I was led by the following experiments.

EXPERIMENT XIX.

NINE ounces of blood were taken from a woman who had been delivered two days before, and who at that time laboured under a fever, with a conſiderable pain in her ſide, and in her *abdomen*. The blood was received into a baſon, and her arm was tied up; when, on looking at the blood, I found its ſurface tranſparent for ſome depth, an indication of a future cruſt; and as her pain was not abated, and as her pulſe could bear it well, I removed the ligature from her arm, and took away about ſix ounces more, into three tea-cups; but what appeared to me remarkable, although the blood flowed as faſt into each of the cups as into the baſon, and when full they were immediately ſet down on the ſame window, yet there was no inflammatory cruſt on the blood in the cups, though a very denſe one on that in the baſon. And again, although the blood in the baſon had been taken away ſome minutes before that in the cups, yet it was later in being completely coagulated; as was evident on comparing them.

I HAD an opportunity of repeating the experiment in the evening; for the ſymptoms of inflammation ſeeming equally violent, it was thought proper by the phyſicians who attended her, to take away more blood; which was done by opening the ſame orifice, when three tea-cups were nearly filled, and ſet in the ſame place; and it was obſerved, that the firſt had a cruſt, though not ſo thick a one as in the firſt bleeding; but the other two cups were without this appearance, though the blood had flowed into them even more quickly than into the firſt †.

EXPERIMENT XX.

A GENTLEMAN, who laboured under an inflammatory complaint, had about nine ounces of blood taken from his arm.

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† As this experiment ſeems contradictory to ſome mentioned hereafter, in the laſt cups being filled rather ſooner and yet coagulating ſooner, which might be ſuſpected to be owing to the veſſel's acting more ſtrongly at the latter part of the operation than at the beginning; it is therefore neceſſary to obſerve, that the difference in this experiment appeared to be only owing to a difference in the ſize of the orifice; for when the ligature was firſt removed, the old wound was not ſo much torn open as it was afterwards, when it was more enlarged in order to haſten the evacuation. But it did not, in the beginning of the operation, trickle down the arm as in Experiment 27; where the ſize of the orifice was not enlarged from the firſt, and yet in proportion as the operation advanced, the velocity of the blood increaſed; which was thence concluded to be owing to an increaſed action of the blood-veſſels.

This quantity was divided into four portions; the firſt was received into a cup, and was in meaſure little more than an ounce; the ſecond, into a baſon, to the quantity of two ounces; the third into a cup, which held one ounce; and the fourth into a baſon, to the quantity of three ounces. Each veſſel was immediately placed upon the window; and it was obſerved that the blood in the firſt was lateſt in coagulating, and had a cruſt over the whole ſurface; that in the ſecond had a cruſt only upon a part of its ſurface; but that in the third and fourth had none, and manifeſtly coagulated before either of the other two.

Now, ſince in theſe experiments the blood in the firſt cups was later in coagulating than that in the laſt; and ſince the blood in the firſt cups alone had a ſize, is it not probable, that even during the ſhort time taken up in the evacuation, the properties of the lymph had been changed, and that it was owing to this change that the ſize diſappeared? It might indeed, at firſt ſight, ſeem poſſible, that the bleeding had only let out the vitiated part; but this is not at all likely; for, ſuppoſe a part only of the blood was vitiated, that part muſt have been equally diffuſed through the whole maſs, and there is no probability of its getting out of the veſſels before the reſt of the blood; and conſequently it ought to have appeared in the laſt equally as in the firſt cup, but it did not. Bleeding, therefore, in thoſe caſes alters the nature of the blood, not by removing the vitiated part, and giving room for new blood to be formed, as has been ſuppoſed; but probably by changing that ſtate of the blood-veſſels, on which the thinneſs, and leſſened tendency of the lymph to coagulation, depends; which ſurely is a very curious circumſtance ‡.

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‡ That the properties of the blood can be changed by emptying the blood veſſels, is likewiſe proved by an

From this obſervation we may be led to think, that it may be uſeful to receive the blood more frequently into ſmall cups, inſtead of a baſon, and to attend more carefully to the alteration produced upon it by bleeding; as we may by that means perhaps learn to determine better, what quantities ſhould be taken away in particular caſes. For it would ſeem probable, that the operation is likely to have the moſt effect on the diſeaſe, in thoſe caſes where the greateſt change is produced by its means, on the diſpoſition of the blood to coagulate; and of that change, we can judge, by comparing the blood in the firſt cup, with that in

an experiment hereafter to be related; where the blood in an animal in health was found to have its diſpoſition to coagulation increaſed, in proportion as the veſſels were emptied, and as the animal became weaker. It may likewiſe be proper to mention, that though the inference is here drawn from two experiments only, yet I have likewiſe obſerved the ſame appearance in other caſes, which I have thought unneceſſary to relate.

the laſt; for the firſt cup will nearly ſhew the ſtate of the blood at the beginning; and the laſt cup the ſtate of the blood at the latter part of the evacuation.

It frequently happens, that inſtead of an inflammatory cruſt over the whole ſurface of the *craſſamentum*, there is only a partial one, which appears in large ſpots or ſtreaks. In ſuch caſes I have obſerved, that only a part of the blood had its diſpoſition to coagulate leſſened, as in Experiment XV. in which ſome of the blood remained fluid and tranſparent, where thoſe ſtreaks appeared, for ſome time after the coagulation had begun in other parts of the ſurface. Now whether in thoſe caſes there had been the ſame difference before the vein was opened, or whether the whole blood had not been of the inflammatory kind, before veneſection, and a part of it was changed as it ran out, or as ſoon as the general fulneſs was diminiſhed, may be a queſtion; but the probability, I think, is much in favour of its being changed during the time of the evacuation, from what was obſerved in the laſt experiments.

When I had obſerved that this diſpoſition of the lymph to coagulate was increaſed by bleeding, or by weakening the action of the blood-veſſels, I ſuſpected that poſſibly in thoſe caſes where the body was very weak, the diſpoſition to coagulate might be ſo much increaſed, that inſtead of being three or four minutes in beginning to do it, after it is let out of the veins (as is the caſe in people in health) it might coagulate in leſs time, or almoſt inſtantaneouſly; for I imagined, that unleſs this took place, we could hardly conceive how the blood ſhould ever have time to coagulate in ruptured veſſels, ſo as to ſtop hemorrhages, as it is believed to do. And upon this occaſion I recollected a remark that I had heard, particularly from Dr. Hunter,

which is, “ That the faintneſs which
“ comes on after hemorrhages, inſtead
“ of alarming the bye-ſtanders, and
“ making them ſupport the patient by
“ ſtimulating medicines, as ſpirits of
“ hartſhorn and cordials, ſhould be
“ looked upon as ſalutary; as it ſeems
“ to be the method Nature takes to give
“ the blood time to coagulate.” Now as this ſeemed to favour my ſuſpicion, I determined to make the experiment.

EXPERIMENT XXI.

BELIEVING it would be ſufficient for this purpoſe, to attend to the properties of the blood, as it flows at different times from an animal that is bleeding to death, I therefore went to the markets, and attended the killing of ſheep; and having received the blood into cups, I found my notion verified. For I obſerved, that the blood which came from the veſſels immediately on withdrawing the knife, was about two minutes in beginning to coagulate; and that the blood taken later, or as the animal became weaker, coagulated in leſs and leſs time; till at laſt, when the animal became very weak, the blood, though quite fluid as it came from the veſſels, yet had hardly been received into the cup before it congealed. I have alſo repeated the experiment, by receiving blood into different cups at different times, whilſt the animal was bleeding to death; and though the time taken up in killing the animal was not commonly more than two minutes, yet I obſerved, on comparing the cups, that the blood which iſſued laſt coagulated firſt*. I have obſerved likewiſe, that the blood coagulates with a different appearance in proportion as the animal becomes weaker; that which follows the knife begins to coagulate in about two minutes; it firſt forms a film or pellicle on the ſurface, which extends gradually through the whole blood, yet ſo ſlowly that its progreſs may be obſerved, eſpecially if the pellicle be moved from time to time. But the blood that comes from the fainting animal is coagulated in an inſtant, after it once begins. From this circumſtance, that the diſpoſition of the blood to coagulate is increaſed as the animal becomes weaker, we may draw an inference of ſome uſe with regard to the ſtopping of hemorrhages, viz. not to rouſe the patient by

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* It may be neceſſary to mention a circumſtance that has occurred in repeating theſe experiments; which is, that although the laſt cup being taken from the animal when much reduced, always coagulated in leſs time than the firſt; yet when four or five cups were uſed, the blood in them did not always coagulate preciſely in the inverſe order of their being filled; for ſometimes the ſecond coagulated

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lated before the third. This circumſtance at firſt ſeemed contradictory to the general concluſion, but on a more careful examination, it was ſuſpected to be owing to the ſtruggles (or temporary exertion of ſtrength of the veſſels) of the animal, and no difference was obſerved in the expoſition to cold or to air.

ſtimulating medicines, nor by motion, but to let that languor or faintneſs continue, ſince it is ſo favourable for that purpoſe; and alſo, that the medicines likely to be of ſervice in thoſe caſes, are ſuch as cool the body, leſſen the force of the circulation, and increaſe that languor or faintneſs *. For, in proportion as theſe effects are produced, the divided arteries become more capable of contracting, and the blood more readily coagulates; two circumſtances that ſeem to concur in cloſing the bleeding orifices †.

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* Beſides giving ſtimulants and cordials to counteract the fainting, it is a common practice in many parts of England, to give women, who are flooding, conſiderable quantities of port-wine, on a ſuppoſition that it will do them ſervice by its aſtringency. But ſurely, from its increaſing the force of the circulation, it muſt be prejudicial in thoſe caſes. Perhaps many of the remedies called ſtyptics might be objected to for the ſame reaſon.

† It has of late been proved by experiments, particularly by thoſe of the ingenious Mr. Kirkland, that the larger arteries, when divided, contract ſo as

It has been queſtioned whether blood-letting can be properly recommended in hemorrhages, excepting in thoſe that are attended with evident ſigns of *plethora*: but do not theſe experiments ſhew, that a vein may be opened with propriety, even where there is no *plethora*, in order ſuddenly to bring on weakneſs; by which the momentum of the blood may be ſo diminiſhed, and the diſpoſition of the lymph to coagulate may be ſo increaſed, as to ſtop the hemorrhage? For, when we conſider how ſoon the blood-veſſels contract, and adapt themſelves to the quantity of blood which they contain, it ſeems

to ſtop the hemorrhage. But the large *coagula* which we ſee in the orifices of the veſſels of the *uterus* of thoſe who die ſoon after delivery, and the ſtopping of hemorrhages where the blood-veſſels were ruptured on their ſides and not entirely divided, make me believe that contracting the bleeding orifice is not the only method nature takes to ſtop an hemorrhage. Her reſources indeed are great, and ſhe has often more methods than one of producing the ſame effect.

not improbable that in ſome caſes where the hemorrhage is not profuſe, but long-continued, the ſtrength of the patient may be ſo recruited, that the diſpoſition to coagulate ſhall not be ſufficiently increaſed, or the extremities of the veſſels ſufficiently contracted, for the ſtopping of the bleeding; but, by emptying the veſſels ſuddenly, this effect may be obtained, and the hemorrhage may be ſtopt by the loſs of leſs blood, than would have happened, had only the ſlow draining been continued.

ALTHOUGH the whitiſh cruſt ſo commonly ſeen in inflammatory diſorders, has ſo very morbid an aſpect, as might induce us to conſider it as inflammatory, and to bleed repeatedly in all thoſe caſes where it occurs, yet I believe we ſhould act improperly: for, to ſay nothing of pregnancy, in which the appearance is almoſt conſtant, there are few phyſicians that have not ſeen patients, who, even in ſuch circumſtances, were the worſe for this evacuation. Nor need we be ſurprized that this ſhould happen, conſidering how ſoon in ſome inſtances this ſize diſappears; and if ſo, may we not ſuppoſe, that it may likewiſe ſoon be formed, even by a ſhort exertion of ſtrength in the veſſels? Perhaps this was the caſe in the gentleman mentioned in page 55, who in leſs than twenty-four hours after bleeding, had ſymptoms of great weakneſs.

As it appears from theſe experiments, that the diſpoſition of the blood to coagulate is increaſed by bleeding, it may be uſeful to attend more to this circumſtance, and to compare the coagulation of the blood in the laſt, with that in the firſt cup, even in caſes that are not attended with the inflammatory cruſt. And it may likewiſe be worth while to make the ſame compariſon in thoſe caſes where every cup has a cruſt; which frequently happens both in rheumatic and in phthiſical complaints. By theſe means we may judge what effect the evacuation has produced on the ſtrength or fulneſs of the veſſels; and may perhaps, by inſpecting the laſt cup, eſpecially if it contains only a ſmall quantity, be able to gueſs pretty nearly at the nature of the blood which remains in the body. In the rheumatic caſe mentioned in page 41, every cup contained this cruſt; and although the blood in the laſt cup coagulated in much leſs time than that in the firſt, yet as it was later in coagulating than common, I ſuſpected what remained in the veſſels had the ſame diſpoſition; but the patient recovered without repeating the evacuation.

It may be mentioned here, that I have once or twice ſeen blood, which, when it firſt began to coagulate, had on its ſurface a red pellicle, and underneath a tranſparent fluid, which afterwards formed a cruſt. In theſe caſes, if the red pellicle had not been removed before the reſt of the blood had congealed, we might have concluded that no part of the blood had this diſpoſition to form a white cruſt. This appearance, I ſhould imagine, was owing to the blood, where in contact with the air, having coagulated before the red particles had time to ſubſide, from that part of the lymph which had its diſpoſition to coagulation leſſened.

The learned profeſſor de Haen has taken notice of a curious appearance of the blood, which he could not account for; but which, I preſume, may be explained from ſome of the above experiments. His obſervation is, "that, "having bled a perſon in a fever, the "blood was covered with an inflamma- "tory cruſt, and upon examining the "*craſſamentum* in one of the cups, he "found that it formed a ſort of ſack

" containing a clear fluid: this fluid " being let out, and the cup ſet by, on " examining it next morning, he ob- " ſerved a very firm cruſt covering the " whole again, and extending to the " bottom of the cup *." I once met with a caſe ſimilar to this; for, having bled a perſon into four cups at ten o'clock in the morning, on looking at the blood afterwards, at five in the afternoon, I found the *ſerum* had not ſeparated from the *craſſamentum* in the firſt cup; but the *craſſamentum* felt as if it contained a fluid in a bag, as profeſſor de Haen has deſcribed it. Upon preſſing it, the fluid guſhed out, and in a few minutes after being expoſed to the air, coagulated: there was however this difference in the two caſes, that in mine the fluid was red, ſo that it formed a red cruſt over the firſt, which was white. Now this ſeems to have been owing to the blood's having firſt coagulated, where it was in contact with the air and with the ſides of the cup; and the fluid which guſhed out was the *ſerum*, with a part of the coagulable lymph, which ſtill remained fluid; but, when expoſed to the air, it jellied or coagulated, as it naturally does. That one part of the lymph can remain fluid after the other is coagulated, is proved by ſome of the preceding experiments; and I have more than once ſeen blood, which appeared perfectly jellied ſoon after bleeding; yet, on cutting into the *coagulum*, a tranſparent fluid has oozed out, which afterwards jellied. And ſo ſlowly does this coagulation proceed in ſome caſes, that in an experiment mentioned before, a part of the blood in a dog's heart was found uncoagulated thirteen hours after death. And I have likewiſe diſtinctly obſerved, that in ſome caſes where the diſpoſition to coagulate was much leſſened during the evacuation, the blood at the bottom of the cup has jellied, whilſt the greateſt part of the *ſize* at the top was yet fluid; there being only a thin pellicle on its ſurface, where it was in contact with the air.

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* Vide Rat. Medendi, cap. vi.

Another inſtance of a change in the properties of this coagulable lymph, which appears curious, was ſeen in ſome experiments, where I had occaſion to throw the blood into water, and into oil, during the winter ſeaſon, whilſt the heat of the water and of the oil was no greater than 41° of Fahrenheit's ſcale. In all thoſe experiments, I found that the diſpoſition to coagulate was leſſened, the blood becoming more and more viſcid, but did not coagulate whilſt in that degree of cold. I ſhall next relate thoſe experiments.

EXPERIMENT XXII.

The jugular vein being properly tied, and then cut out from a rabbit juſt killed, was thrown into water of 41° of heat, and taken out at the end of half an hour; when the blood was found to be ſtill fluid, though rather more viſcid than natural; but, after being expoſed to the air, it coagulated.

EXPERIMENT XXIII.

Two pieces of the jugular vein of a dog, juſt killed, were put into water, in which the thermometer ſtood at 41°; one was taken out after twenty minutes, and the other after three quarters of an hour; the blood in both was found to be fluid, and to coagulate afterwards.

As it was evident from theſe experiments, that the water had leſſened the diſpoſition of the blood to coagulate, I next enquired to what property in the water this effect could be owing; and to ſee whether water that was warmer would not have the ſame effect, I made the following experiment.

EXPERIMENT XXIV.

ON December the thirteenth, I cut out two pieces of the jugular vein of another dog, immediately after his death. One piece was put into cold water, and the other into water kept warm by a lamp, ſo that the heat never varied more than between 90 and 100°. At the end of three quarters of an hour, that in the warm water had in it a *coagulum* as large as a garden-pea; but that in the cold water, being let out into a cup, was quite fluid. Twenty minutes after being expoſed to the air, that which had been in the cold water was coagulating; but that from the warm water neither then nor afterwards ſhewed any ſigns of farther coagulation: ſo that it ſeemed not only to have jellied whilſt in warm water, but to have begun to part with its *ſerum*. From this experiment, it ſeems probable that the *coldneſs* was that property of the water to which the leſſened diſpoſition to coagulate was owing; but, to be more ſure of this, and to ſee whether the blood might not be kept fluid a longer time by theſe means, I tried as follows:

EXPERIMENT XXV.

On January the fourteenth, I cut out a piece of the jugular vein of another dog, and put it into oil, in which the thermometer ſtood at 38°. At the end of ſix hours it was taken out, and the red particles were obſerved through the coats of the vein to have moſtly ſettled to one ſide. The blood was let out into a cup, and was found to be fluid; at the end of fifteen minutes above one half was ſtill fluid; in twenty-five minutes it ſeemed to be quite jellied. Now as in this experiment a ſimilar effect was produced, as when the vein was put into water, it ſeems probable that it was the coldneſs of the water, and of the oil, which had leſſened the diſpoſition of the lymph to coagulate.

EXPERIMENT XXVI.†

ANOTHER piece of the ſame vein was put into river-water, in which the thermometer ſtood at 38°, and was left till the next morning; when, after twenty-two hours and a quarter, it was taken out. The red particles did not ſeem to have ſubſided, as in the former experiment; but the vein being opened the blood was found to be fluid, though ſo viſcid that it could barely drop from the veſſel. The cup into which it was received was placed upon the window of a moderately warm room, and was examined carefully from time to time; but the blood never had any appearance of coagulation, on the contrary, it remained fluid till it was dried by the evaporation of the water, which happened by the next day. In this experiment the cold ſeemed entirely to have prevented the coagulation of the lymph: ſo ill-founded is the common opinion, that cold coagulates the blood.

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† It is neceſſary to obſerve here, that great expedition ſhould be uſed in making theſe experiments; for, unleſs the vein be cut out in a few minutes after the death of the animal, the experiment may not ſucceed, from the blood's having begun to coagulate.

As the lymph, on being cooled, is deprived of its power of coagulating when expoſed to the air, may we not thence be led to explain that fact mentioned by Liſter, that the blood of thoſe cold animals which ſleep during the winter-ſeaſon, on being let out into a baſon, does not coagulate? And thence, as he obſerves, remains always fit for motion.

CHAP. IV.

Some further obſervations on the coagulable lymph, and on the ſudden changes produced upon it.

IF the reader has been perſuaded of the common opinion, that the diſpoſition of the blood to coagulate is increaſed in inflammatory diſorders, it may perhaps appear to him, as it formerly did to me, a very extraordinary circumſtance that the contrary ſhould be true; and likewiſe that the blood ſhould in reality be the more diſpoſed to concrete, in proportion as the body is weakened, or as the action of the blood-veſſels is diminiſhed. And as we are naturally tenacious of old opinions, and unwilling to adopt new ones till fully proved, he may ſuſpect that there has been ſome fallacy in theſe experiments. And indeed I muſt acknowledge that there is, in appearance, one ſtrong argument againſt my general concluſion, which is, that it has not only been remarked, that the firſt cup has a cruſt, whilſt the laſt has none; but likewiſe, that the ſecond, or the third cup, alone ſhall have a cruſt, whilſt the preceding ones are without it. Now this, I ſay, ſeems contradictory to what I have advanced, concerning the diſpoſition of the blood to coagulate being increaſed in proportion as the body is weakened; for here in proportion as the blood is evacuated, its diſpoſition to coagulate is leſſened; ſince it was more ſizy in the ſecond, or third cup, than in the firſt. But, in anſwer to this objection, I muſt remark, that theſe caſes very ſeldom occur; and that in general the firſt cups are more ſizy, and are the lateſt in jellying; and when the contrary takes place, or when the ſecond or third cup is more ſizy than the preceding, I am perſuaded, that upon a careful examination, inſtead of weakening, they will be found to ſtrengthen my inference; as will appear probable by the following caſe, which has occurred ſince theſe experiments were publiſhed in the Philoſophical Tranſactions.

EXPERIMENT XXVII.

On the 13th of June, I viſited a young man, twenty-two years old, of an athletic habit, who complained of a violent pain in his head and back, with a full ſtrong pulſe; but as he was then in a profuſe ſweat, which had been preceded by a ſhivering, it was not thought proper to bleed him, and the rather, as we were informed, that he had had a ſimilar paroxyſm two days before. But next day, finding that his fever had not left him with the ſweat, and that he ſtill had a pain in his head and back, and that his pulſe, though not now full and ſtrong, yet was quicker than natural, it was then judged neceſſary to take away ſome blood. Upon opening the vein, the blood flowed very ſlowly, and indeed merely trickled down his arm. Imagining that the bandage might be too tight, I ſlackened it, but ſtill the motion of the blood was not accelerated. I then aſked him whether he had not been afraid of the bleeding, and he told me he had; and on feeling his pulſe in the other arm, I found it very low. I therefore deſired him to move the muſcles of his hand, which he did; but nevertheleſs ſo ſlowly did the blood run, that it was four minutes before I got an ounce and an half into a cup. I then ſtopt the orifice till another cup was brought, into which the blood ran in a full ſtream, to the quantity of three ounces, and that in two minutes, although the orifice was rather ſmall, ſo much was its velocity now increaſed. Into the third cup, which likewiſe held three ounces, the blood ran ſtill faſter, as it was filled in leſs than two minutes. By this time the patient beginning to be faint, I ſtopt the bleeding till he could lie down on the floor, and then about three drachms more of blood were received into a fourth cup: this came away very ſlowly, and the bleeding ſtopt of itſelf. He drank a glaſs of water, and did not faint, and he appeared afterwards to be much relieved by the evacuation. Upon this blood I made the following remarks:

THAT which was taken away laſt was firſt coagulated, and completely too, by the time I had tied up his arm, which was in three minutes from the blood's firſt running into the cup.

THE blood which was received into the firſt cup coagulated next, and as I obſerved by my watch, in twelve minutes from its being ſet down on the table.

THAT which was received into the ſecond cup was the third in order as to coagulation, and was conſiderably later in jellying than the firſt; for in fifteen minutes it was not thoroughly coagulated; nay, even in twenty-two minutes a ſmall part of it was ſtill fluid. It was remarkable, that none of theſe three had any ſize.

BUT the blood in the third cup differed conſiderably from that in the others; for in five minutes it began to appear tranſparent on its ſurface, an indication of a future ſize, and it was later in coagulating than that in the other cups; for even at the end of twenty-ſix minutes a great part of the coagulable lymph was ſtill fluid, as appeared on removing the pellicle that covered it; but in thirty-five minutes it was completely jellied. The ſize in this blood was very thick and tough.

Now this caſe, when carefully examined, inſtead of being an objection to my concluſions, will, I preſume, be thought a ſtrong confirmation of them.

For, in the firſt place, as the blood in the third cup alone had a cruſt, and was much later in jellying than the reſt, it ſtrengthens my inference, that the diſpoſition of the blood to coagulate is leſſened in thoſe caſes where the inflammatory cruſt or ſize appears. And as the blood ran more rapidly into this cup, it ſhewed that the heart and blood-veſſels had begun to act with greater force, and therefore confirmed the opinion, that in proportion as theſe act more ſtrongly, the diſpoſition of the lymph to coagulate is diminiſhed. The ſame opinion is likewiſe ſupported by obſerving what happened to the blood in the firſt cup, which coagulated ſooner than that in the third, owing to the veſſels then acting more weakly, as was evident from the blood's trickling down the arm, and from the lowneſs of the pulſe *.

2dly, It may be obſerved, that the great difficulty in admitting the concluſion made in the former part of theſe ſheets (viz. that the want of ſize in the laſt cup is occaſioned by an alteration in the blood-veſſels) was to conceive how theſe veſſels could poſſibly alter the properties of the lymph ſo ſuddenly, as in the time between receiving the blood into the firſt cup, and into the laſt. But this caſe confirms that inference, by ſhewing the fact in a clearer point of view; for even here, where the appearance of the ſize was reverſed, it was found that the blood which had a cruſt or ſize was lateſt in coagulating, and that it was this blood which was taken out of the veſſels when they acted moſt ſtrongly, as was proved by the rapidity with which it flowed into the cup.

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* In like manner may be explained another variety in the appearance of the ſize, namely where it is found in the firſt and laſt cups, but not in the ſecond or third: this I ſuſpect ſeldom happens, but when it does, it may perhaps be found, on examination, that the veſſels were acting more weakly whilſt the ſecond or third cups were filled. For, ſo eaſily does this ſize appear to be removed, or formed, that I ſuſpect it may ſometimes happen, that when the blood is taken away, in a full ſtream, from a large orifice, the patient may be ſo ſuddenly weakened, and the properties of the blood may in conſequence be ſo changed by the time the ſecond cup is filled, that the ſize ſhall be removed: and yet afterwards the veſſels may recover their former tone, ſo that the third or fourth cup may acquire a ſize again. Nay, I ſuſpect that this appearance may even be affected by the paſſions, particularly from obſerving that the patient abovementioned, as well as others whoſe blood at firſt trickled ſlowly down their arms, had been much afraid of the lancet.

3*dly*, SINCE the times in which the blood jellied in theſe cups were ſo very different (the firſt coagulating in twelve minutes, the ſecond in about twenty-two, the third in thirty-five, and the fourth in leſs than three minutes, notwithſtanding theſe cups were filled in leſs than two minutes after one another) it ſhews, I ſay, how ſoon that ſtate of the blood-veſſels on which the ſize depends, can be removed and aſſumed, and therefore leads us to conclude, that although this ſize is in general a ſign of an inflammatory diſorder, or a ſtrong action of the veſſels, yet there may be ſeveral circumſtances to be taken into the account, before we can judge from its preſence, or abſence, whether or no veneſection ſhould be repeated: and it likewiſe ſhews clearly, that it would be improper to determine, from the preſence of this alone, when bleeding is neceſſary; and yet there have been not a few who have inclined to make ſuch a concluſion, from their conſidering this cruſt or ſize as ſo very morbid an appearance.

4thly, As the blood in the third cup was ſo late as thirty-five minutes in coagulating, and was ſizy, whilſt that in the fourth was not ſo, and jellied in leſs than three minutes, although it had been taken from the veſſels only two minutes after the other, but at the time the patient had become faint; it ſhews how much faintneſs and languor increaſe the viſcidity of the blood, and likewiſe its diſpoſition to coagulate, ſince in two minutes they produced ſuch a change as to remove the ſize, and to reduce the time of coagulation from thirty-five to three minutes. It therefore ſhews clearly how much languor and faintneſs ſhould be encouraged in hemorrhages, and how carefully we ſhould avoid giving any thing that can ſtimulate, or rouſe the patient; that the medicines likely to be of ſervice are nitre and the acids; or ſuch as cool the body, or have the property of diminiſhing the force of the circulation, or of increaſing that languor or faintneſs *; that

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* It has been objected here, that nitre would ſeem improper for this purpoſe, becauſe in experiments

that all agitation of mind ſhould, as much as poſſible, be prevented, leſt it increaſe the circulation: that all muſcular motion ſhould be avoided for the ſame reaſon: for that an exertion of the patient's ſtrength can leſſen the diſpoſition of the blood to coagulate, I am perſuaded from ſome of the abovementioned caſes, and likewiſe from what I have obſerved in dying ſheep, where the ſtruggles of the expiring animal ſeemed in ſome inſtances,

ments mentioned before (p. 12.), it was found to prevent the coagulation of the blood, out of the body; but this objection is removed, by conſidering, that, in order to prevent coagulation, the nitre muſt be uſed at leaſt in the proportion of two ſcruples to every two ounces of blood. But, when we exhibit it internally, we ſeldom give more than a ſcruple every two hours, which can have no effect in attenuating the whole maſs of blood, nor in preventing coagulation; eſpecially as we have reaſon to believe its properties are changed, before it paſſes the digeſtive organs. Its good effects in hemorrhages, therefore, are probably owing to its action upon the ſtomach. For proofs of its utility, ſee *Medical Obſervations* and *Inquiries*, vol. IV. art. xvi.

when violent, to alter the properties of the lymph.

We have endeavoured to explain the appearance of the inflammatory cruſt or ſize, from the red globules having ſubſided from the ſurface of ſuch blood before it coagulated: this we obſerved was partly owing to the lymph's being later in coagulating in thoſe caſes, but principally to its being thinned. But we may now add, that although the attenuation of the lymph, and its leſſened tendency to coagulate, are connected in moſt of thoſe caſes, yet they do not always go together; for the lymph may have its diſpoſition to coagulate leſſened without being thinned; which was evident in the preceding caſe, on comparing the blood in the ſecond with that in the third cup; for the blood in the ſecond cup had no ſize, notwithſtanding it remained fluid at leaſt ten minutes after the ſize had begun to appear in the third: this I attribute to the blood in the third being more attenuated, and thereby more readily allowing the globules to ſubſide.

That the blood may have its diſpoſition to coagulate leſſened, without being attenuated, is likewiſe probable from the following caſes.

EXPERIMENT XXVIII.

In the month of January I bled a man, who complained of a pain in his head, attended with giddineſs and ſhivering, a pain and ſickneſs at his ſtomach, and with a full and quick pulſe: the blood was found to remain fluid for ten minutes, and then jellied, but no ſize appeared.

EXPERIMENT XXIX.

In another perſon, who was bled merely for a drowſineſs, and becauſe he was accuſtomed to that evacuation in the

Spring, I found the blood remain ſeven minutes without coagulating, and yet it was without any ſize.

Now, ſince in theſe caſes the blood remained ſo long fluid, and yet the red particles did not ſubſide, or no ſize appeared, I ſhould conclude, that only the diſpoſition of the lymph to coagulate was leſſened, without its being thinned. And from the laſt caſe we may likewiſe conclude that although the times, at which the blood taken from perſons in health begins to coagulate, be allowed to be about three minutes and an half, as I have found from repeated obſervations, yet there may be ſome variety in this reſpect; for a *plethora* and other circumſtances may make it later in coagulating in ſome caſes, even where the patient is otherwiſe in perfect health *.

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* This inference is confirmed by a caſe mentioned below, Experiment 32.

We have obſerved before, that the ſize is ſometimes very firm, and at other times ſpongy and cellular; theſe differences in its denſity are, I ſuſpect, in proportion to the degree of attenuation and leſſened diſpoſition of the blood to coagulate; for as the coagulation begins on the ſurface, and forms there a film which attracts the reſt of the lymph, the more that lymph is attenuated, and the ſlower it coagulates, the more will the film be able to ſeparate it from the red globules, and from the ſerum: thence perhaps it is, that when the blood, beſides being very thin, likewiſe jellies ſlowly, we ſometimes ſee almoſt the whole coagulable lymph collected at the top, forming a firm cruſt, which being free from the ſerum, as well as from the globules, contracts the ſurface into a hollow form. But when the blood has its diſpoſition to coagulate leſs diminiſhed in proportion to the attenuation, then, although the globules ſubſide from the ſurface, yet the whole of the lymph jellies ſo ſoon after the coagulation begins, that there is not time for its being ſeparated from the ſerum, of which it therefore contains a conſiderable quantity, and is of courſe more ſpongy and cellular.

In proportion to the thickneſs and denſity of the ſize, the bottom of the cake is of a looſer texture; but this looſeneſs of texture is not owing to putrefaction, as has been ſuſpected, but merely to the lymph's being collected at the top, and therefore leaving the bottom of the *craſſamentum*.

Notwithstanding bleeding does in general weaken the action of the veſſels, increaſe the diſpoſition of the blood to coagulate, and even thicken the lymph; yet it may happen, that, in the ordinary quantity in which blood is taken away, none of theſe effects ſhall be produced; of this the following caſe ſeems to be an inſtance.

EXPERIMENT XXX.

A WOMAN in the ſeventh month of her pregnancy was bled for a violent pain in her ſide, attended with a cough; the quantity taken away was eight ounces, which was received into four cups; and as the orifice was ſmall, about ten minutes were ſpent in the bleeding. On attending to the different cups, I could obſerve no difference in the periods at which the coagulation commenced, and finiſhed in each, allowance being made for the time the blood began to run into each. In every one of theſe cups the blood was completely jellied in about twenty minutes, and each had a cruſt or ſize nearly of the ſame thickneſs. So that the bleeding ſeemed not to have produced any change in the ſtrength of the patient's veſſels, nor was her pain ſenſibly abated by it. She was therefore deſired to live low, to confine herſelf to a vegea vegetable diet, and to take a ſcruple of nitre every three hours in a draught of the *decoctum pectorale*; and if her pain and cough were not abated in a day or two, ſhe was directed to repeat the bleeding. As cloſe attendance was not required, I did not viſit her till four days after, and then ſhe had got free of her complaints, notwithſtanding her blood had been apparently ſo little changed in the time of the evacuation.

In this caſe the bleeding ſeemed neither to have thickened the lymph, nor increaſed its diſpoſition to coagulate, nor weakened the action of the veſſels; but that it generally produces theſe effects, cannot, I think, be doubted, from our having obſerved it in ſo many inſtances. Perhaps the dread of the operation might here have made the coagulation of the blood in the firſt cup approach nearer to that in the laſt; or perhaps the ſmallneſs of the orifice prevented there being ſo manifeſt a change produced by the evacuation, from its giving time to the blood-veſſels to adapt themſelves more equally to the quantity they contained, by which means ſhe was not weakened by the loſs of blood.

It has been obſerved by Sydenham and others, that it ſometimes happens, even in inflammatory diſorders, when the blood trickles down the arm, inſtead of running in a full ſtream, it does not acquire a cruſt or ſize *. May not this be

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* It may be neceſſary to obſerve, that it is not in every caſe where the blood trickles down the arm that it is without a ſize; on the contrary, it ſometimes happens, that even in ſuch circumſtances it has a very denſe one; an inſtance of which may be ſeen below, in Experiment XXXI. In thoſe caſes the trickling down the arm may perhaps be owing to ſome circumſtance in the orifice preventing its flowing in a full ſtream, or to a difference in the tightneſs of the ligature, rather than to a weak action of the veſſels. Or, although the ſize be occaſioned by a ſtrong (or ſome particular mode of) action

be explained from what is obſerved in the caſe related in Experiment XXVII? that is, in ſuch inſtances the veſſels, either from a febrile, or from ſome other oppreſſion, act more weakly than they do in the ordinary caſes of inflammation; by which means the lymph is not ſufficiently attenuated to allow the red globules to ſubſide before the coagulation begins, and therefore the ſize does not appear, as in other caſes of inflammation where there is no ſuch oppreſſion.

As air is found to coagulate the blood and cold to thicken it, an objection has thence been made to the concluſions from ſome of the preceding experiments; and it

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action of the veſſels, and therefore is removed by weakening them, yet it may not always be removed immediately on their being weakened. For it may happen, that in ſome caſes the lymph may not be ſo ſuſceptible of changes as in others; or when it has been very much attenuated it may not again be thickened immediately, on the veſſels acting weakly.

it has been ſuppoſed, that the changes in the properties of the blood, that happen during the time of bleeding (which I have attributed to a difference in the action of the veſſels) might poſſibly be owing merely to a difference in the expoſition to the air, or to cold. For inſtance, ſince the blood that trickles down the arm ſeems to be more cooled than that which flows in a full ſtream, it has thence been ſuppoſed, that its want of ſize, in thoſe caſes, might be owing to the expoſition to the air, which made it coagulate ſooner, and to the cooling which had thickened it, and thereby prevented its red particles from ſubſiding ſo that the ſize ſhould be formed. This objection is indeed plauſible, and to thoſe who have not ſeen theſe experiments, might at firſt ſeem ſufficient to explain the appearance; but upon further examination it will not be found to do it ſatisfactorily. Thus, for example, although it be true that air coagulates the blood, and likewiſe cools it, yet there are changes remarked in the preceding experiments that cannot be explained merely by a difference in the expoſition to the air: Thus, in Experiment XXVII. the blood in the third cup was thirty-five minutes in being completely coagulated, whilſt that in the fourth, although taken from the arm only two minutes later, yet coagulated in three minutes. Now no expoſition to the air, nor to cold, from the blood's trickling down the arm, could produce ſuch a change. Of this I am perſuaded from what I have obſerved on comparing the blood received into a cup, with that which dropt on the plate which held the cup; for I have repeatedly ſeen on thoſe occaſions, that the blood on the plate, although it was ſo much more cooled and ſo much more expoſed to the air, than that in the cup, yet inſtead of coagulating proportionably ſooner, was later in being coagulated. The following experiment ſhews this clearly.

EXPERIMENT XXXI.

A YOUNG woman with a violent inflammation in her eyes, was bled on the 5th of March, early in the morning, before ſhe had breakfaſted, and whilſt ſhe was complaining of a ſickneſs at her ſtomach; the blood followed the lancet in a ſtream, but immediately after it only trickled down the arm, and continued to do ſo during the whole of the evacuation. About eight ounces of blood were taken away into four veſſels, viz. into two cups and two ſaucers, in the following manner: A plate holding both a cup and a ſaucer was held under the arm, and the blood was firſt received into the ſaucer, to the quantity of a ſpoonful, then as much more was received into the cup that ſtood by it; then again the blood was ſuffered to run into the ſaucer, and afterwards into the cup, and ſo alternately till there was about two ounces in each, when they were carefully ſet down on a window where the thermometer ſtood at 57°; the plate was placed by them, and contained about a ſpoonful of blood, which had miſſed the ſaucer in the beginning of the evacuation. Next, the ſecond plate was brought, and ſome blood was received firſt into the cup and then into the ſaucer, in the ſame manner; and three portions of blood were ſuffered to drop at different times on the plate, each of them about the breadth of a ſhilling. Now, here, according to the reaſoning in the objections made to ſome of the preceding experiments, the blood in the ſaucers having twice as much ſurface as that in the cups, ought to have coagulated in half the time; and that on the plates ought, from the largeneſs of the ſurface to have coagulated in much leſs time; but juſt the contrary happened; for the blood in the cups was firſt completely coagulated, that in the ſaucers next, and that on the plates lateſt of all. But, as the experiment ſeems curious, it may be proper to give a more particular detail of what was obſerved.

On looking at the firſt plate, at the end of ſeven minutes after it was ſet down on the window, the ſurface of the blood in the cup was conſiderably tranſparent, and a pellicle (that is the ſurface beginning to coagulate) was formed upon it; but no tranſparency was diſtinguiſhable on that in the ſaucer, nor could any pellicle be obſerved upon drawing a pin through it, or through that which had dropt upon the plate. At the end of fifteen minutes the blood in the cup and in the ſaucer were pretty much coagulated, or had a thick pellicle, whilſt none could yet be obſerved on that upon the plate. At the end of fifty-five minutes that in the cup was juſt beginning to part with its ſerum, whilſt the blood in the ſaucer was not yet completely coagulated; for on inclining it to one ſide, a part of the blood appeared fluid under the pellicle. That on the plate was now coagulated. They were all three ſizy; and the blood in the ſaucer had a ſize which ſeemed to be as firm, and in as large a quantity, nearly, as that in the cup; and the ſize upon the blood in the plate was thick enough to be eaſily diſtinguiſhed.

In the ſecond plate, at the end of ſeven minutes after being ſet on the window, both the blood in the cup and in the ſaucer were beginning to coagulate; and had a pellicle of a conſiderable thickneſs, and were both ſizy: but no pellicle appeared on any of the three portions that had dropt on the plate. At the end of fifteen minutes, that in the cup was firmly jellied, that in the ſaucer not quite ſo much, and one of the ſpots on the plate was but juſt beginning to coagulate at its edge. At the end of twenty-five minutes, the two laſt ſpots were ſtill perfectly fluid, but in twenty-eight minutes they were beginning to coagulate; whilſt the blood in the cup was now parting with its ſerum. At the end of fifty minutes a conſiderable quantity of ſerum had ſeparated in the cup, and the ſeparation was juſt beginning in the ſaucer.

THIS experiment was repeated on another perſon's blood two days after, in the preſence of Mr. Field and Mr. Hendy, two ſtudious gentlemen, at that time living at the Middleſex Hoſpital, and the appearances were exactly ſimilar; and it was evident to them that the blood in the ſaucers was later in coagulating than that in the cups, and that on the plates (one of which was of pewter) was conſiderably later in jellying than that in the cups or in the ſaucers.

THESE experiments therefore ſhew clearly, that the differences in the periods of coagulation, and in the appearance of ſize upon the blood received into the different cups in bleeding, cannot be accounted for from a difference in the expoſition to air; for here blood more expoſed to the air than that is which trickles down the arm, is found equally ſizy, and to be even later in coagulating than blood leſs expoſed.

As we have here obſerved a new circumſtance that appears remarkable, and which at firſt ſight ſeems not reconcilable to ſome of our concluſions, it may therefore be neceſſary to examine it farther, or to enquire, If air be a coagulant of the blood (as we have endeavoured to prove in the beginning of this Eſſay) how comes it that in this experiment the blood was not coagulated proportionably to its expoſition to the air? This, I think, may be explained from conſidering another fact that was mentioned in the preceding pages, *viz.* that cold leſſens the blood's tendency to coagulation. The blood, therefore, in the ſaucer, although it was more expoſed to the air, yet being more cooled than that in the cup, was, for that reaſon, later in coagulating; and that on the plate, which was moſt expoſed to the air, being moſt cooled, was therefore lateſt of all.

But we may add, that although it be evident from this experiment, that the difference in the expoſition to air, or to cold, is not ſufficient to explain the changes which we ſee produced upon the blood, in ſo little time as in the filling of a ſmall cup, eſpecially when thoſe changes are ſo great as what are mentioned in Experiment XXVII (where the blood in one cup was thirty-five minutes in coagulating, and had a very thick ſize, whilſt that taken away ſoon after, coagulated in three minutes, and was without a ſize) yet, I think, that the effects of air, and of cold, are conſiderable enough to deſerve to be taken into the account in ſome caſes, where the changes on the blood are not ſo great. For as cold thickens the blood, it is probable that in ſome caſes where the lymph is but little attenuated, and where therefore, in the ordinary manner of bleeding, there would have appeared but very little ſize, ſuch blood, if more expoſed to the air ſo as to be ſooner cooled, may thereby have the ſmall degree of attenuation counteracted, or removed, and the red particles may be prevented from ſubſiding. So that although in this experiment, where the ſize was thick, it appeared equally in the ſaucer as in the cup, and even appeared on the blood upon the plate; yet, if we repeat theſe experiments on a variety of ſubjects, it is probable, that we may ſometimes find the ſaucer without a ſize, whilſt the cup has one; for when the lymph is but little attenuated a ſlight cauſe may thicken it again; and its being a little more cooled in the ſaucer and on the plate, may in ſome caſes be ſufficient to prevent the ſize from appearing.

It has likewiſe been ſuggeſted, that poſſibly there might be ſome difference in the orifice, from which the blood flowed, to which its different appearances in the ſeveral cups might be owing. But there does not ſeem to be any foundation for this objection, and it may, I think, be removed by a careful examination only of ſome of theſe experiments, particularly the 27th; for there the blood ran in a full ſtream both into the ſecond cup and into the third, the orifice being apparently unaltered, and yet there was a great difference in the appearance of the blood: for that in the third cup had a thick ſize, but that in the ſecond had none. So that there does not ſeem to be any circumſtance attending theſe experiments that can explain the changes produced upon the blood in the time of bleeding, excepting that to which I have attributed it, *viz.* a change in the ſtrength of the blood-veſſels, or in their mode of action; and every obſervation I have yet made confirms me in that opinion.

A VERY eminent phyſician ‡, after reading the firſt edition of theſe ſheets, informed me, that from a ſuggeſtion which he met with in Profeſſor Simſon's Diſſertations, *viz.* "That a ligature on the "arm would produce a ſize †," he had been for many years cautious how he took any indications from this appearance of the blood, and deſired I would endeavour to determine, by experiment, whether the ligature's being a longer or ſhorter time upon the arm, even in the ordinary way of bleeding, might not influence this appearance of the blood. And accordingly in the preſence of Dr. Drummond, Mr. Field, Mr. Hendy, and Mr. Cockſon, I made the following experiment.

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‡ Dr. Fothergill.

† Dr. Simſon's obſervation is, that if a tight ligature be made on the limb, and the vein opened three hours after, a ſize will be produced.—*Vide De Re Medica, Diſſert.* iii. *Sect.* 38. p. 112.

EXPERIMENT XXXII.

On the 9th of October, I tied up both the arms of a healthy young man with a degree of tightneſs ſufficient to make the veins ſwell and become turgid, whilſt the pulſe remained free; a vein in one arm was opened immediately after making the ligature, and an ounce of blood was received into a cup. I choſe to take away ſo ſmall a quantity that there might be the leſs probability of producing any change upon the blood by weakening the body. The ligature was left upon the other arm for an hour, which made the veins very turgid, and likewiſe made the perſon complain of a ſtiffneſs in his fore-arm; the artery in his wriſt being felt all the time, but leſs diſtinctly than in the other arm which was without a ligature. At the end of an hour this vein was opened, the orifice was large, and an ounce of blood was taken away. Upon attending carefully to each cup, it did appear that the ligature had produced ſome change; for in the firſt place, the blood which had been ſo long detained in the arm by the ligature was darker coloured, or blackiſh, whilſt that from the other arm was more florid, even at its firſt running from the vein. 2dly, The blood that had been ſo long in the arm was rather later in being coagulated; for it did not begin to part with its *ſerum* till at the end of thirty-ſeven minutes after puncturing the vein; whilſt in the other the coagulation was completed, and the *ſerum* was beginning to ooze out in thirty minutes. 3dly, The blood which was firſt taken away was without a ſize, whilſt that which had been ſo long in the other arm had a ſmall ſpot about the breadth of a ſilver penny, and did not cover a twentieth part of the ſurface.

From this experiment, therefore, it would ſeem, that a ligature long continued may produce a ſize, agreeably to Dr. Simſon's obſervation, but then it will probably be only in ſmall quantity.

The ſame learned gentleman, on being informed of the reſult of this experiment, ingeniouſly ſuggeſted, that the quantity of blood which I had taken away might perhaps be too little to make the experiment deciſive; for, as only one ounce of blood had been taken from each arm, all that blood might be ſuppoſed to have been contained in the veins themſelves; and as it was more probable that the diſpoſition to ſize took place in the arteries, a larger quantity ſhould be taken away, in order to judge whether the blood in the arteries had not been changed by the veins of the arm being ſo long compreſſed. The experiment was, therefore, repeated upon the ſame perſon, on the 7th of March, Mr. Field and Mr. Hendy aſſiſting me as before, and we obſerved as follows:

EXPERIMENT XXXIII.

THE blood from the arm firſt opened was in quantity about ten drachms, had no ſize, but was late in being completely coagulated. The pellicle firſt appeared on its ſurface ſix minutes after opening the vein, and at the end of fifteen minutes a conſiderable quantity of the blood was ſtill fluid; but in thirty-four minutes it was completely coagulated. The *ſerum* did not begin to ooze out till at the end of fifty minutes.

AFTER the other arm had been tied up an hour, the vein was opened, and about ten drachms of blood were received into the firſt cup; as much more into a ſecond; and about an ounce and an half upon a pewter plate; and about two ounces and an half into a third cup (in all ſix ounces and an half) and it was obſerved, that the blood in the third cup and that in the ſecond coagulated in about twenty minutes, and the *ſerum* began to ooze out in twenty-five minutes after opening the vein; the blood on the plate was later in coagulating, and none of theſe portions of blood had the leaſt appearance of ſize. But the blood in the firſt cup was conſiderably the lateſt in jellying; for at the end of twenty-five minutes a large quantity was ſtill fluid under the pellicle, and even at the end of fifty minutes, the coagulation was incomplete. This blood ſeemed to have rather more ſize than that in the former experiment, but it was not collected at one part, but was diffuſed over the ſurface, and appeared in ſpots not bigger than pins heads.

The reſult therefore of this experiment was ſimilar to the preceding. The ligature long continued produced a ſize, but in ſmall quantity; and therefore it does not appear probable, that, when the ligature has been only a few minutes on the arm (as is the caſe in the ordinary manner of bleeding) it can deſerve to be taken into the account, when we judge of the diſeaſe, or of the indications of cure from the appearance of the ſize: eſpecially when it is conſidered, that the blood on which theſe experiments were made was very favourably circumſtanced for Dr. Simſon's opinion; that is, it was from a patient who ſeemed to be plethoric, by the blood which was firſt taken away not jellying in leſs than thirty, and thirty-four minutes, which is later than ordinary, as appears from what is obſerved above, page the 40th, where we found, that the blood of people in health commonly jellies in ſeven or eight minutes, As many of theſe experiments ſhew how eaſily the diſpoſition of the lymph to coagulate can be altered, even by ſlight changes, as it would ſeem, in the ſtate of the blood-veſſels, they help us to explain how it ſhould happen, that the blood, in ſome diſeaſes, is found without this property of jellying; an inſtance of which is mentioned by Monſ. de Senac *; another was obſerved by the learned profeſſor Cullen; and a third I ſaw lately by the favour of Dr. Huck and the phyſicians of the Britiſh lying-in hoſpital, who, having bled a woman in a fever that came on ſoon after delivery, found her blood did not coagulate on being expoſed to the air, but appeared like a mixture of the red globules and *ſerum* only, the globules having ſubſided to the bottom in the form of a powder. She died three days after, and, upon opening her, we found the blood had coagulated in her veſſels after death, and that a tough white *polypus* was formed in each auricle of the heart, one of which I have now by me. I examined the blood taken away before ſhe died, and found, on expoſing it properly to heat, that it did not coagulate ſooner than *ſerum* commonly does, nor under 160°; ſo that it is probable, that, at the time ſhe was bled, her blood either was without the coagulable lymph, or its properties were changed.

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* Traité du Cœur, Tom. 2. p. 129.

AFTER a blow or contuſion, the blood now and then burſts from the veſſels into the cellular membrane, ſometimes forming an *ecchymoſis*, and ſometimes a tumor, and it is a queſtion with ſome, whether ſuch blood coagulates or not; but that it coagulates in moſt of theſe caſes, is proved by opening ſuch tumors. Yet it has likewiſe been obſerved, that now and then theſe tumors have been attended with a fluctuation, and that, after ſome time, their contents have been abſorbed,

ſorbed, and it has alſo been found, that, upon opening ſome of them, even ſeveral weeks after the accident, the blood was fluid. In ſuch caſes the blood had probably undergone a change ſimilar to what was obſerved to take place in ſome of the preceding experiments, that is, the lymph had been deprived of its property of coagulating, in paſſing from the blood-veſſels into the tumor: a circumſtance, which, how remarkable ſoever it may appear, agrees with what we have above obſerved of the lymph, whoſe properties ſeemed to vary with the ſtate of the blood-veſſels.

CHAP. V.

Containing a recapitulation of the principal facts and concluſions that are mentioned in the preceding pages.

THE ſeparation of the blood into *craſſamentum* and *ſerum*, in a given time, appears to be in proportion as the heat in which it ſtands is nearer to that of the human body. The heat in which the blood is kept ſhould therefore be attended to, when we draw inferences from the proportions of theſe two parts.

THE florid colour of the ſurface of the *craſſamentum* ſeems to be owing to the air. The venous blood, in paſſing through the lungs, has a ſimilar change produced upon it, or becomes more florid by the time it gets into the arteries; and this florid colour is again loſt in paſſing from the ſmall arteries into the veins, eſpecially if the perſon be in health. But ſometimes in diſeaſes it does not undergo this change, but comes florid out of the veins.

NEUTRAL ſalts, on being mixed with the blood out of the body, make it more florid: they likewiſe, if uſed in great quantity, prevent its coagulation when expoſed to the air, and ſome of them allow the lymph to be precipitated, or to jelly on being diluted with water. But we are not to conclude from thence, that they would produce the ſame effects when uſed as medicines; for then they are only given in ſmall quantities, and may have their properties changed by the digeſtive organs, before they are mixed with the blood. And as they are moſt of them cooling and ſedative, they produce nauſea and languor of the ſtomach, and leſſen the force of the vaſcular ſyſtem. And as the properties of the blood ſeem to depend on the action of the veſſels, theſe ſalts may thus, by affecting the veſſels, produce changes on the blood very different from what might have been ſuſpected, from obſerving what takes place when a large quantity of them is mixed with the blood out of the body.

THE blood is not coagulated (I do not mean thickened, for it is indeed thickened) by cold, but on the contrary, has its diſpoſition to coagulate leſſened, and even entirely taken off, if the expoſition to cold be long continued. When therefore the blood in the baſon jellies, it is not the cold that produces this effect, nor is it the want of motion; for although the blood by being at reſt will jelly at laſt, yet it will not do it in the time the coagulation takes place in the baſon; which in the blood of healthy perſons is in ſeven or eight minutes after being received from the vein. The coagulation of the blood in the baſon is therefore probably owing to the air.

When the blood is at reſt in the body, it will at laſt coagulate merely for want of motion; but this coagulation takes place with different appearances from that of the blood in a baſon, for it begins in ten or fifteen minutes, and is not completed in three or four hours; whilſt the blood of the ſame animal, taken out of the veins, and expoſed to air, will begin to jelly in three or four minutes, and will be completely jellied in ſeven or eight.

The effect that air has upon the blood is not immediate on its application, but takes place ſooner or later, in different circumſtances of health; in ſome caſes the blood is coagulated in a few ſeconds after it has been expoſed to the air, in others not in leſs than an hour and an half, or perhaps more, as appears from Experiment XIV.

The inflammatory cruſt or ſize is not a new-formed ſubſtance, but is merely the coagulable lymph ſeparated from the reſt of the blood. This ſeparation ſeems to be occaſioned by the lymph's being attenuated, by which means the red particles ſoon ſettle to the bottom, and leave the ſurface of the blood tranſparent; and this tranſparent part being a mixture of the coagulable lymph and the ſerum, the former coagulates on its ſurface where, in contact with the air, and the diſpoſition to coagulate being likewiſe diminiſhed, the blood remains a long time fluid, and thereby gives time for the pellicle formed on its ſurface to attract the reſt of the lymph, and to collect it at the top, leaving the bottom of the cake proportionably ſofter. The ſize therefore is thicker, and denſer, in proportion as the lymph is thinned, and is leſs diſpoſed to concrete. But it is not a certain ſign of inflammation, and does not appear to be the cauſe of that diſeaſe, but only its effect.

BUT the moſt remarkable concluſion that theſe experiments have led to, is, that the properties of the blood depend on the ſtate of the blood-veſſels, or that they have a plaſtic power over it, ſo as to be able to change its properties in a very ſhort time. The novelty of this opinion, and the difficulty of conceiving how the veſſels ſhould have ſo remarkable a power, has made ſome object to the concluſion, who had not well conſidered all the facts from which it was deduced. I ſhall here therefore ſum up theſe facts.

THAT the blood-veſſels, by their ſtronger or weaker action, can change the properties of the lymph, even in the ſhort time ſpent in filling the different cups in bleeding, is firſt inferred from Experiment XIX. where the blood in the firſt cup had a ſize, whilſt that in the others had none. Now as this want of ſize in the laſt cups was owing to the lymph's having by this time become thicker, and to its being more diſpoſed to coagulate, and no other circumſtance being obſerved that could account for this alteration (for the difference in the expoſition to cold, or to air, even then, appeared inadequate to the effect, and are now proved to be ſo by Experiment XXXI.) I concluded, that it was entirely owing to an alteration in the ſtrength with which the veſſels acted upon the blood. And to this opinion I was led by the well-known fact, that bleeding weakens the body; and as bleeding, which weakens the body, had here removed the ſize, by thickening the lymph, and by diſpoſing it more to coagulate, I thence inferred that it was by its weakening the body, or the action of the veſſels, that it had produced thoſe changes on the lymph. The conſideration of what takes place in inflammations confirmed me in this opinion; for in them the blood-veſſels are known to act more ſtrongly, and it is proved above, that the lymph is proportionably thinned, and has its diſpoſition to coagulate proportionably diminiſhed.

AND this opinion was further ſtrengthened, by obſerving what occurs when an animal is bled to death, or when the veſſels are acting with the loweſt degree of ſtrength; for here it was found, that in proportion as the ſtrength of the animal was reduced, the blood was more and more diſpoſed to coagulate.

AND having thus obſerved the connection between the alterations in the lymph, and changes in the ſtrength of the blood-veſſels, in theſe caſes, I next inferred, there might be the ſame correſpondence, even in others where the changes in the properties of the lymph are more ſudden, as in Experiment XXVII. where there was no ſize in the firſt cup, but a thick one in the third; and even this caſe, when carefully examined, confirmed the inference; for the blood-veſſels were found to be acting with different degrees of ſtrength, at the very time that the lymph was found to have different properties. And the only difficulty that remained here, was to explain how it ſhould happen, that the firſt cup, contrary to what in general takes place, ſhould have its blood coagulated in leſs time than the ſecond or third; and this I concluded was owing to ſome febrile cauſe, affecting or oppreſſing the patient; in which concluſion I am confirmed by the fact admitted amongſt phyſicians, that the pulſe is frequently oppreſſed in inflammatory diſorders, and riſes in ſtrength in proportion as blood is taken away.

FROM this concluſion I went further, and conjectured that even temporary exertions of ſtrength in the blood-veſſels might alter the properties of the lymph; to which opinion I was led by having obſerved the blood ſizy in the caſe mentioned in Experiment XX. where great weakneſs ſoon followed the evacuation; and likewiſe from having obſerved, that the ſtruggles of dying ſheep ſeemed to alter the lymph.

So that upon the whole, the opinion agrees with all the appearances, and is ſupported by all the differences in ſtrength that occur in the various deviations from the ſtandard of health; for when the veſſels act more ſtrongly than they do in health, the lymph is proportionably more thinned, and is leſs diſpoſed to concrete; and when the veſſels act more weakly than in health, then the lymph is proportionably thickened, and is more ready to concrete. Is it not therefore probable, that the differences we obſerve in the thickneſs or thinneſs of the lymph, and in its being more or leſs diſpoſed to coagulate, are owing to theſe differences in the ſtrength of the blood-veſſels? For ſuch alterations in the ſtrength of the blood-veſſels are always connected with thoſe of the lymph, and we can obſerve no other circumſtance connected with thoſe changes of the lymph that can at all explain them.

And although it muſt be admitted, that it is very difficult to conceive how the blood-veſſels ſhould do this, yet I ſhould hope that ingenious men would not merely on that account reject my concluſion; but would conſider, that as it is deduced from a number of experiments, as it agrees with all the appearances, and as it leads to an explanation of many of them which we cannot otherwiſe account for; it may be well founded although it be difficult to be conceived. For there may be powers in the animal œconomy that are not yet dreamt of in our philoſophy.

THIS obſervation of the properties of the blood depending on the ſtate of the veſſels, beſides explaining many morbid appearances, leads to a further application; for we may thence be led to advance more rational and more certain rules for the treatment of hemorrhages. For as hemorrhages ſeem to be ſtopped, partly by a contraction of the bleeding orifices, and partly by the coagulation of the blood, and as the diſpoſition of the blood to coagulate is increaſed by weakening the body, and likewiſe the contraction of the bleeding orifices is promoted by the ſame means, it is therefore evident, that the medicines to be uſed, ſhould be ſuch as cool the body, and leſſen the force of the circulation; and experience teaches us, that ſuch are the moſt efficacious.

It likewiſe ſhews, that all agitation of mind, and all bodily motion ſhould as much as poſſible be prevented; becauſe they increaſe the force of the circulation, and are thence unfavourable to the ſtopping of the hemorrhage. But that languor and faintneſs being favourable to the coagulation of the blood, and to the contraction of the bleeding orifices, ſhould not be counteracted by ſtimulating medicines, but on the contrary ſhould be encouraged. And as evacuations weaken the body more when they are ſudden, we ſee a reaſon why blood-letting ſhould be adviſable in hemorrhages, and why a large orifice ſhould be preferable to a ſmall one, when we want to produce that languor or faintneſs, or that weak action of the veſſels, ſo uſeful for the ſtopping of the hemorrhage.

Before we conclude, it may be added, that the practice here propoſed is far from being new or uncommon; but as ſome have recommended oppoſite methods, and both parties have appealed to experience, where authority ſo equally balances authority, the young practitioner muſt be at a loſs which to follow, and for want of principles to direct his choice, may frequently adopt the worſt practice: witneſs the uſe of port-wine, and other ſtimulating aſtringents, which is ſo very common in moſt parts of England.

CHAP. VI.

Of the Serum *of the blood, and particularly of the milk-like* Serum.

THE *ſerum*, when ſeparated from the *craſſamentum*, by letting the blood reſt in the baſon into which it is received, is a fluid, apparently homogeneous and tranſparent; of a yellowiſh colour, ſaltiſh to the taſte, in conſiſtence thicker than water, and its ſpecific gravity, according to Dr. Jurin, is to water as 1030 to 1000*.

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* Philoſ. Tranſ. No. 361.

When chemically examined the *ſerum* is found to conſiſt of a mucilaginous ſubſtance, which is diſſolved in a water that contains a ſmall quantity of neutral ſalts. The mucilaginous ſubſtance of the *ſerum* agrees with the coagulable lymph of the blood in being fixed or coagulated by heat; but the degree neceſſary for the coagulation of the *ſerum* is greater than that which is neceſſary for fixing the lymph, for the lymph is coagulated by a heat between 114 and 120[1] degrees of Fahrenheit's thermometer; (ſee Experiment IX.) whilſt the *ſerum* requires 160° to coagulate it: (ſee Experiment X.)

But the degree of heat neceſſary for their coagulation, is not the only circumſtance in which the lymph differs from the mucilage of the *ſerum*; they differ more remarkably in the former coagulating when expoſed to air, whilſt the *ſerum* undergoes no ſuch change.

When the *ſerum* is coagulated by heat, a watery fluid can be preſſed out of it; and this fluid the learned *M. de Senac* diſtinguiſhes by the name of Seroſity.

This ſeroſity contains the neutral ſalts of the blood, and although it has been expoſed to the heat of boiling water, yet it ſtill contains a part of the mucilaginous ſubſtance, which is combined with the water in ſuch a manner, as not to be coagulated by the heat of boiling water, till a part of the water is evaporated by boiling; and then it coagulates and appears not very much unlike the mucus ſpit up from the *aſpera arteria* in a morning.

When the mucilaginous part of the *ſerum* has been coagulated by heat, it cannot again be diſſolved in the Seroſity, except by putrefaction, or by the addition of ſome chemical ſubſtance, and then it differs from what it was before, particularly in its not being coagulable by heat.

But if the *ſerum* be expoſed to a leſs degree of heat than is required for its coagulation, for example, to that of 100°, it is gradually inſpiſſated into a browniſh, ſolid maſs, and this maſs can readily be diſſolved again merely by the addition of water; and the *ſerum* ſeems to poſſeſs the ſame properties that it did before, particularly it is capable of being coagulated by heat. But care muſt be taken not to add more water than it had loſt, for if more be added than was evaporated, it alters its properties of coagulation.

In this circumſtance of being inſpiſſated, and again rendered diſſolvable in water, the *ſerum* agrees with the white of an egg †, but differs from the coagulable lymph, which even when mixed with a neutral ſalt, (viz. true Glauber's ſalt) cannot be inſpiſſated, and diſſolved again without coagulation.

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† See Newmann's Chemiſtry, Sect. IX.

If freſh *ſerum* be diluted with an equal quantity of water, and then expoſed to heat, it does not coagulate in that of 160°, as when undiluted, nor even in the heat of boiling water, as I have lately obſerved, but it can now be boiled without immediately coagulating. And as the water evaporates, a pellicle is formed on the ſurface, which becomes thicker and thicker as the evaporation advances. This pellicle ſeems to be the mucilage coagulated, for it cannot again be diſſolved in water like the inſpiſſated *ſerum*.

Milk, when boiled, has its mucilage or coagulable part ſeparated in like manner, in the form of a pellicle, in proportion as the evaporation takes place.

And both milk and ſerum, whether diluted or not, agree in being coagulated by rennet *, when expoſed to heat. So that milk ſeems to be made of the mucilaginous part of the *ſerum*, or is a diluted *ſerum*, with the addition of an expreſſed oil, or with a ſaccharine ſubſtance inſtead of the neutral ſalts.

But although there is an analogy between milk and diluted *ſerum*, in the circumſtance of coagulation, yet they differ in another; namely, diluted *ſerum* can by a moderate heat be inſpiſſated without coagulating, or forming any pellicle on its ſurface, but if milk be expoſed to the ſame heat, it is not inſpiſſated ſo completely; for a pellicle is formed on its ſurface, in proportion as the evaporation takes place, and this pellicle ſeems to be as perfectly coagulated as if the milk had been expoſed to a boiling heat; for it will not diſſolve again merely by adding water, as inſpiſſated *ſerum* does.

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* Which is an infuſion of the 4th ſtomach or the *abomaſus* of a calf.

SERUM, therefore, by being diluted, comes near to milk in the circumſtance of its coagulation. But the coagulable lymph cannot, by any art yet diſcovered be made exactly to reſemble *ſerum*.

THE mixture with neutral ſalts makes it indeed ſo far approach to the nature of *ſerum*, as not to be coagulated by expoſition to the air; but it does not alter ſo conſiderably its property of coagulating by heat, for the mixture with Glauber's ſalts (in Experiment VII.) coagulated at 125°; and, I believe, would coagulate in a heat of 123°, if long expoſed to it; whilſt the pure coagulable lymph is fixed between 114° and 120½, and the *ſerum* not under 160 degrees of Fahrenheit's thermometer.

Of the white Serum.

ALTHOUGH the *ſerum* of human blood be naturally tranſparent, and a little yellowiſh, yet it is frequently found to have the appearance of whey, and ſometimes to have white ſtreaks ſwimming on its ſurface like a cream, and now and then to be as white as milk, whilſt the *coagulum* is as red as uſual. In all theſe three caſes of whiteneſs, I have examined it in a microſcope with a pretty large magnifier, and have found it to contain a number of very ſmall globules, although naturally, when tranſparent, no globules can be obſerved in it, notwithſtanding what has been affirmed by ſome authors. Theſe globules differ from the red particles (improperly called globules) in their ſize, which is much ſmaller; and likewiſe in their ſhape, which is ſpherical, whilſt the red particles are flat. They agree more with the globules of milk.

I have compared them with thoſe of woman's milk, and have found, that in the milk the globules are of different ſizes, ſome being three or four times as large as others, and the ſmalleſt little more than juſt viſible, when viewed with a lens of $\frac{1}{23}$ of an inch focus, whilſt thoſe of the white *ſerum* are more regular, and are all of them about the ſize of the ſmalleſt globules of milk. Of this white *ſerum* I have met with the following inſtances in books. In Tulpius, one inſtance [*], in Morgagni two [†], in the Philoſophical Tranſactions ſome inſtances [‡], in Sckenckius's Obſervations two caſes are related from other authors [‖]. I have likewiſe heard of the ſame appearance having been obſerved by the learned Sir John Pringle, Dr. Pitcairn,

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[*] Tulp. Ob. l. 1. cap. 58.

[†] Morgagni, Ep. XLIX. Art. 22.

[‡] Philoſoph. Tranſact. N° 100, and 442.

[‖] Sckenckij. Obſ. lib. 3.

Dr. Hunter, Dr. Watſon, Dr. Bromfield, Dr. Garthſhore, and Dr. Fothergil of Northampton. And other inſtances have lately occurred to perſons of my acquaintaince, who have favoured me with a ſhort account of them.

Mr. French, apothecary in St. Alban-Street, having informed me, that he had ſome blood by him, taken from a woman the day before, whoſe ſerum was as white as milk; he favoured me with a ſmall quantity of it for examination, and with it the following particulars of the caſe. "Mary Rider, about twenty-"five years of age, of a freſh com-"plexion, and luſty, has not had her "menſes for theſe ſeven months. She "diſcharges blood ſometimes by vomit-"ing, and ſometimes by ſtool; com-"plains of a pain in her left ſide, and "in her ſtomach: ſhe has an inclination "to eat, but when ſhe tries, ſhe ſoon "after loathes her food. She com-"plains of great laſſitude and ſleepineſs;

" her pulſe is ninety-five in a minute.
" She has been bled twelve times within
" theſe ſix months, and every time the
" *ſerum* was as white as milk."

MR. ROBERTSON, apothecary in Earl-Street, acquainted me, that " Mr. Her-
" bert, a publican, of about thirty-five
" years of age, and corpulent, had been
" ſubject to a bleeding at the noſe, to
" the piles, and to ſuch profuſe ſweats in
" the night, as to be frequently obliged
" to change his ſhirt in the morning
" before he got out of bed, but that, for
" ſome time paſt, his ſweats had ceaſed.
" That, on September the 23d, he was
" ſeized with a bleeding at his noſe,
" which had been preceded by a pain in
" his head for two or three days. That
" his bleeding continued till he had loſt
" about two pounds of blood, and then
" ſtopt; and that the ſerum of his blood
" was as white as milk. That at ten
" o'clock the ſame night, the hemorrhage
" returned, and he loſt a conſiderable

"quantity; nevertheleſs, it was thought "proper to take ſixteen ounces of blood "from his arm, during which evacuation he fainted, but his bleeding at the "noſe ſtopt. That the *ſerum* of this laſt "blood was likewiſe very white. That "on the 25th, in the morning, he again "complained of a pain in his head, and "about ten o'clock his noſe began to "bleed again; but the *ſerum* now appeared no whiter than whey. That "he continued to loſe blood during moſt "part of the night, ſo that it was ſuppoſed he could not loſe leſs than two "or three pounds, the ſerum all this "time being a little whitiſh, but ſo little, "that the bottom of the veſſel in which "it ſtood could now be ſeen through it. "That his bleeding returned repeatedly "till the third of October, when it "entirely ſtopt, the *ſerum* having become more tranſparent towards the "laſt."

Mr. Eustace, apothecary in Jermyn-Street, ſent me a phial of white *ſerum* from one of his patients, by trade a butcher. "This man," he told me, "was tall, of a ſtrong make, a hard "drinker, ſubject to puke every morning, took little food, ſweated a good "deal, but did not waſte in his fleſh. "He was bled for a ſlight *aſthma* to "which he was ſubject, and of which "he had always been relieved by bleeding. In other reſpects he was in a "good ſtate of health, ſo as to follow "his buſineſs without much inconvenience."

Besides theſe caſes, my friend Mr. Lambert, ſurgeon at Newcaſtle upon Tyne, told me, "that he had a patient "ſome years ago with a violent rheumatic pain in his hip, whom he was "obliged to bleed thrice, and every time "his *ſerum* was as white as milk, but "the *coagulum* of its natural colour.

" This gentleman," Mr. Lambert adds,
" was a free liver, of a full make, but
" rather muſcular than corpulent, and
" remarkable for being a great walker."

When I firſt ſaw this unuſual colour of the *ſerum*, I was inclined to adopt the opinion of thoſe who have attempted to explain it by the patient's being bled ſoon after a meal, or before the chyle was converted into blood. But afterwards, on conſidering the caſes above related, I found this could by no means be the cauſe, as none of theſe patients had taken a ſufficient quantity of food to occaſion this appearance; on the contrary, moſt of them had a bad appetite, and had taken remarkably little food, and were ſubject to vomitings. I therefore concluded it was owing to ſomething elſe, and what confirmed me in this opinion, was an obſervation I had repeatedly made in diſſecting geeſe, whoſe *ſerum* I had frequently ſeen white, whilſt their chyle was tranſparent; although they had been killed only three or four hours after eating. And as the whiteneſs, in all the caſes that I examined, was owing to a quantity of ſmall globules like thoſe of milk (which are known to be oily) I concluded that theſe in the human *ſerum*, when white, were oily likewiſe, and recollecting to have read ſomewhere of an experiment by which butter had been got from ſuch human *ſerum*, I tried, by agitating ſome of it a little diluted, to ſeparate its oil, or to churn it, but without ſucceſs. I then inſpiſſated ſome of it to dryneſs, and compared it with the natural *ſerum* of human blood prepared in the ſame way, and found it leſs tenacious, and much more inflammable; and when thus dried, its oil oozed out ſo much as to make the paper in which it was kept greaſy. Another portion of this white *ſerum* being kept ſome days, putrefied, and when putrid, it jellied as milk does when become ſour; but it differed from milk, in being extremely fœtid.

Now, as the white globules appear from theſe experiments to be of an oily nature, and as it is improbable, from theſe patients having taken little food, and from the tranſparency of the chyle in birds, that this whiteneſs of the *ſerum* ſhould be owing to unaſſimulated chyle, accumulated in the blood-veſſels; we muſt therefore believe it to be owing to ſome other cauſe. And as we know there is a conſiderable quantity of oil laid up in the cellular ſubſtance of animals, which is occaſionally re-abſorbed, is it not moſt probable that this curious appearance was, in the abovementioned caſes, owing to ſuch a re-abſorption? And as all theſe patients had ſymptoms of a *plethora*, and were relieved either by ſpontaneous hemorrhages, or by blood-letting, is it not probable, that, to whatever purpoſe the oil is applied in the body after it is re-abſorbed from the cellular membrane, in theſe patients it had been re-abſorbed faſter than it was applied, and by that means was accumulated in their blood-veſſels? This conjecture ſeems to be confirmed, from conſidering that in moſt of theſe caſes the people were inclined to corpulency, and that two of them laboured under a ſtoppage of a natural evacuation *.

ANOTHER concluſion which theſe obſervations lead us to, is, that ſince the chyle of the birds which I diſſected was not white, but tranſparent, at whatever time after eating it was examined,

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* Although it appears probable that the whiteneſs of the *ſerum* in the above-mentioned caſes was not owing to the chyle, yet I would not conclude that the chyle does not in the human ſubject occaſionally colour the *ſerum*. We frequently obſerve the *ſerum* of ſuch people as are bled a few hours after a meal, a little turbid, like whey, which I believe may be owing to the chyle. But if the milk-like ſerum was occaſioned by a full meal, it is likely we ſhould oftener ſee it than we do.

it follows, that the fat (in theſe animals at leaſt) is not merely the oily part of the chyle or of the food; but is a new ſubſtance, or a new combination of the principles or elements, which is made probably in the ſecretory organs of the adipoſe membrane: the form of oil being made uſe of by Nature in preference to any other for the nutritious ſubſtance of the body, from its being the leaſt liable to putrefaction, and from its containing the greateſt quantity of nouriſhment in the leaſt bulk. This circumſtance was clearly proved by my valuable and ingenious friend the late Dr. Stark, who, in a courſe of curious experiments, made by weighing himſelf after living for ſome time on different ſorts of food, diſcovered that a leſs quantity of ſuet was ſufficient to make up for the waſte of his body, than of any other ſort of ordinary food; and that, when compared with the lean part of meat, its nutritive power was, at leaſt, as three to one.

I MAY here add another circumſtance that occurred to me when I firſt thought on this ſubject, which is, that ſince we believe the oil, or animal fat, is re-abſorbed from the adipoſe membrane to ſerve for nouriſhment to the body; and as ſome of the patients (whoſe caſes have been related above) could not take food, the re-abſorption therefore of this oil might not be ſo much the cauſe, as the effects of the diſorder under which they then laboured: or, in other words, that upon ſome defect in the digeſtive organs, the powers of nature drew from their magazines of oil in the adipoſe membrane, a ſupply of that fluid then perhaps neceſſary for the uſe of the body. In order to clear up this point, I thought it would be a ſatisfactory experiment, to compare the *ſerum* of the blood of animals at different periods after feeding them. For, if the re-abſorption of the oil was merely to make up for the want of other food, or, if the *ſerum* was white merely from a greater quantity of oil being taken up, in order to ſupply the wants of the body, then the *ſerum* ought to be whiteſt in the animal kept longeſt without food, or whoſe body was moſt in want. And as I had found that geeſe had very commonly this white *ſerum*, though their chyle was tranſparent, I choſe to make the experiment on them. I therefore took two of them that were very hungry, and feeding both of them with oats, one I killed four hours after, when I knew a part of the oats were undigeſted; and upon examining the blood, I found the *ſerum* whitiſh, and full of ſmall globules; on its being ſuffered to ſtand a little time, the white part aſcended to the ſurface like a cream. The other was killed forty-eight hours after eating, when its ſtomach was found empty, and the *ſerum* of its blood quite tranſparent, and without any cream riſing to the ſurface, or any appearance of ſmall globules, when examined with the microſcope. Now, this experiment ſeemed to me deciſive, and to point out clearly, that the whiteneſs of the *ſerum* was not occaſioned merely by the body being in want of food, and therefore, drawing the oil from its magazines; becauſe here the animal moſt in want of food had its *ſerum* leaſt white; but was occaſioned by the fat's being re-abſorbed faſter than it was uſed (from its place being ſupplied by the freſh chyle) and thence was accumulated in the blood-veſſels, ſo as to give whiteneſs to the *ſerum*. And from the ſame obſervation it likewiſe appears probable, that the great re-abſorption, and the accumulation of the fat in the veſſels of the plethoric patients above-mentioned, was the cauſe of their want of appetite, and of their other complaints, and not the effect of them.

MAY not therefore a too great re-abſorption of the fat, and its accumulation in the blood-veſſels, be now admitted as the cauſe of one ſpecies of a *plethora?*

AND may it not likewiſe be uſeful in ſome complaints of the ſtomach, to attend to the whiteneſs of the *ſerum?* For, although fat be a ſubſtance little liable to diſeaſe, yet it may perhaps be ſometimes ſo vitiated or may ſo incommode nature, that ſhe may be obliged to take it up from her magazines, and to uſe it, or to throw it out of the body. Whilſt this is doing, a ſickneſs of the ſtomach, and want of appetite, may be indications of fulneſs; and therefore, inſtead of wanting remedies to ſtrengthen the ſtomach, may require bleeding, and other evacuations.

APPENDIX,

RELATING TO

THE DISCOVERY

OF THE

LYMPHATIC SYSTEM

IN BIRDS, FISH, AND THE ANIMALS CALLED AMPHIBIOUS.

BEING

A Vindication of the AUTHOR's Right
to theſe Diſcoveries, in Oppoſition to
the Claim of Dr. ALEXANDER
MONRO, Profeſſor of Anatomy in
the Univerſity of Edinburgh.

APPENDIX.

AN account of the Lymphatic Syſtem in Birds, Fiſh, and Turtle, was given to the public in the Philoſophical Tranſactions, vol. lviii. and lix. for which communications the Royal Society has ſince honoured me with their gold medal. Theſe diſcoveries Profeſſor Monro claimed, in a letter read before that moſt reſpectable body on the 19th of January 1769; and has ſince perſiſted in that claim, in a pamphlet called, A State of Facts, &c. printed at Edinburgh 1770. Now, as both that letter and the pamphlet muſt of courſe have been ſeen by many who know not what can be urged againſt them, I think it but a duty I owe my own character, to lay before the Public the proofs I have collected of their inſufficiency to procure Profeſſor Monro the credit of having anticipated me in thoſe diſcoveries; and, I hope, that, although in doing this I ſhall treſpaſs on the time and patience of the reader, yet it will be ſome excuſe for me, that I had endeavoured, as much as could be expected on my part, to ſettle the diſpute without troubling the Public with it.

As Profeſſor Monro has, in this pamphlet, not only endeavoured to vindicate his claim to theſe diſcoveries, but has likewiſe cenſured me on account of a paper on the *emphyſema*, it is neceſſary, before I come to the controverſy about the lymphatics, that I ſhould relate what has paſſed between us on that occaſion.

In the third volume of the Medical Obſervations and Inquiries, is publiſhed a paper on the *emphyſema*, in which I propoſed the operation of the *paracenteſis* of the thorax, to let air out of the cavity of the cheſt; which air I endeavoured to ſhew was the cauſe of the worſt ſymptoms attending that diſeaſe. Not long after this, I was informed that Dr. Monro had declared publicly, he had mentioned that obſervation in his lectures; both at the time, and before I attended them, which was in the winter 1761, and complained, that I had omitted doing him juſtice in this particular.

When I heard this, I made inquiries of ſome of his pupils, who I found had taken notes at his lectures, and by two of theſe gentlemen I was favoured with excerpts from their notes, which convinced me that he had anticipated me in propoſing that improvement. I then determined to let him know, that my omitting to mention his name on that occaſion was entirely owing to my ignorance of his claim. This I was the more deſirous of doing, from having heard that he had exclaimed againſt me with ſome acrimony, on the ſuppoſition that I had got the hint from him, and was conſcious of it; which being far from the truth, I determined to ſhew him in what manner I had really made the obſervation, and thereby ſtop his exclamations. I determined likewiſe to ſhew him that I was deſirous of giving him the credit of having had the idea before me, and thereby to prevent all diſpute about the matter. The following is a copy of the letter which I ſent him on that occaſion.

SIR,

Being informed that you have publicly complained of me, "for having, "in a paper printed in the third volume "of the *Medical Obſervations* and *Inquiries*, omitted doing you the juſtice "of mentioning your having propoſed "the operation there recommended, in "the ſame circumſtances, long before;" and as I am confident I deſerved not to be complained of on that account, I have taken this opportunity of ſtating the manner of my making the obſervation, and at the ſame time of letting you know, that ſince I have learnt that you likewiſe had made it, I am willing to do you juſtice. The thought firſt occurred to me in reading Mr. Cheſton's Pathological Inquiries and Obſervations, in which he gives a caſe of the *emphyſema*: this caſe is told in ſuch a manner, that I think it is hardly poſſible any unprejudiced perſon ſhould read it and not be convinced, as I was, that the cauſe of the principal ſymptoms was air in the cavity of the cheſt. Mr. Cheſton himſelf, in relating that caſe, came as near making the obſervation as poſſible †. From this hint I proſecuted the ſubject, as is mentioned in that paper; and before I publiſhed it, I conſulted every author I could eaſily procure, who I thought was likely to treat of the ſubject. And I certainly ſhould have done juſtice to any that I found had anticipated me, and ſhould not have avoided the opportunity of doing you the ſame juſtice. But I knew not, at the time of that publication, that you had ever given the leaſt hint on that ſubject. About the middle of laſt ſummer I was told by a gentleman from Edinburgh of your manner of treating me, at which I was not a little ſurpriſed, as I was not conſcious of having given you the leaſt cauſe of complaint. But having ſince learnt, from other gentlemen who attended your lectures before the time of my publiſhing that paper (and who, at my requeſt, conſulted their notes) that you had really mentioned it, I cannot now doubt that you had made the obſervation before me. At the ſame time I muſt aſſure you, that to ſuppoſe I knew it at the time of publiſhing that paper was doing me injuſtice. Your accuſation, I preſume, is founded on the ſuppoſition of my having heard you deliver the obſervation at your lectures, when I had the pleaſure of attending them. But I do aſſure you, that if I ever heard the leaſt hint on that ſubject, either from you, or from any other perſon, I had not any remembrance of it, at the time I wrote that paper. You are not, indeed, the only perſon who, as I now find, has anticipated me: the author of the Monthly Review for laſt June * ſays, he had long had the ſame idea, and that he mentioned it in his account of Mr. Cheſton's book. But of this too I aſſure you I was ignorant, when I wrote my paper. What muſt give farther conviction to any unprejudiced perſon of my ignorance of your having made the obſervation, is this: I firſt mentioned it in a paper which I read to a private ſociety, in which were

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† I have ſince been informed by Mr. Cheſton, that I had miſunderſtood his meaning, when I concluded that he explained the worſt ſymptoms of the *emphyſema* on different principles from what I have done, and that he meant to attribute them to air in the cheſt, and therefore, that the obſervation was ſufficiently made out in his paper; which ſee in his Pathological Inquiries and Obſervations, p. 7, and 8.

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* See Monthly Review for June 1768, p. 446.

preſent many gentlemen that had attended your lectures, and yet all theſe gentlemen expreſſed themſelves pleaſed with the obſervation, as new and intereſting, and not one of them gave the leaſt intimation of their having ever heard it before. And yet thoſe gentlemen are as likely to remember any obſervation which tends to the improvement of phyſic or ſurgery, as any I know. I ſhall mention their names, to juſtify my good opinion of them; Drs. Stark, Parſons *, Saunders †, Pepys ‡, and Ruſton §. The obſervation was likewiſe mentioned in another ſociety of young gentlemen, and alſo in a public hoſpital, where many, who had been your pupils, heard it, and yet no perſon

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* Profeſſor of anatomy at Chriſt's-Church, Oxford.

† Phyſician to Guy's hoſpital.

‡ Phyſician to the Middleſex hoſpital.

§ Some of theſe gentlemen attended Dr. Monro's lectures about the ſame time with myſelf, the others ſince.

ever told me before I publiſhed that paper (which was almoſt a twelvemonth after I had firſt mentioned the ſubject), that you or any other perſon had ever anticipated me. However, this I relate only to ſhew I was ignorant at that time of your having made the obſervation. But now I know that you had, I have not the leaſt unwillingneſs to acknowledge it, and to do you juſtice in any future publication. At the ſame time that I juſtify my own conduct, give me leave to ſay, that your manner of treating me (if fairly repreſented) was not ſo civil as might have been hoped for, When you complained of me, 'tis a pity you had not likewiſe hinted there was a poſſibility of my being ignorant of your having had the idea. You might perhaps too without impropriety have hinted, that ſhould it come to my ears that you had anticipated me, I might poſſibly be capable of ſuch an exertion of candour as to acknowledge it. But, to have done with ſuppoſitions, this at leaſt I am ſure of, that though I may be as covetous of fame as moſt people, yet I am incapable of taking any unjuſtifiable methods of acquiring it.

I am, Sir, &c.

Dec. 31, 1768.

THIS letter, Profeſſor Monro could not but acknowledge, "ſufficiently ſatiſ-"fied him in having ſecured his title, as "the firſt who had propoſed that im-"provement." Yet ſo unfair an account does he give of it in his State of Facts, that he only ſays, I acknowledged, that "I could not doubt he had made the ob-"ſervation before me; but the farther "particulars of it (he adds) it is needleſs "to trouble the reader with, ſince as "much as is neceſſary of theſe will be "ſufficiently underſtood, from his letter "in anſwer" to me, which, ſurely! is not the caſe; for it no where appears in his letter, that, beſides mentioning my conviction of his having anticipated me, I had likewiſe promiſed to do him juſtice in a future publication. Nor does it appear in his letter, that I had in mine ſhewn how little probability there was of my having got the idea from him. Theſe the reader may perhaps think Profeſſor Monro ought to have declared, in juſtice to me. For what more could be expected of me, ſeeing I had by accident hit upon an obſervation, which, as it happened, he had made before, than to acknowledge the priority of his title, as ſoon as I knew it, and to put that letter into his hands by which he might always be ſure of ſecuring to himſelf what was his due. But Profeſſor Monro ſays, it was unneceſſary to give a fuller account of my letter. But why was it ſo? Not ſurely in juſtice to me, nor for the ſatisfaction of the reader.——Nay, ſo far is Dr. Monro from doing me juſtice on this occaſion, that he even intimates I rejected tapping the cheſt with a *trocar*, becauſe it happened to be his method, as if the ſame was not the method recommended by many of the writers on the ſubject of the *paracenteſis* of the thorax, for the caſes in which they adviſe that operation, to whoſe method I alluded, and not to his, which I then knew nothing about.

NEXT, as to the diſcovery of the Lacteals and Lymphatics in Birds, Fiſh, and the animals called Amphibious; of theſe an account was laid before the Royal Society on December the 8th, 1768. I was preſent when it was read, and had afterwards ſome converſation on the ſubject with Dr. Donald Monro, who, as appears by the ſequel, informed his brother, the Profeſſor, of what I had done. Not long after this, I again ſaw Dr. Donald at St. George's Hoſpital, and he then told me, that the *Lymphatics* and *Lacteals* in thoſe animals * had been diſcovered by his brother eight years ago, as he now learnt by a letter from Edinburgh, a part of which letter he was to ſhew to every body, and which was already given to be read before the Royal Society. When I was informed of this, I was aſtoniſhed, as I remembered to have heard the Profeſſor, ſince that time, declare that they were not diſcovered. Beſides, I had a note taken from his lectures within two years of his making this claim, in which was a ſimilar acknowledgment *. I was convined therefore that he had no title to theſe diſcoveries. Upon which I laid before the Royal Society my reaſons for that conviction, in a letter to one of their ſecretaries. Of this letter I ſhall give the reader an account, but ſhall firſt lay before him a literal copy of Dr. Monro's claim.

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* Meaning Birds and Fiſh.

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* That note is now printed below, p. 176.

Copy of Dr. Alexander Monro's *claim, &c. read before the Royal Society, Jan.* 19, 1769.

" Above four years ago (ſays he) I
" injected the lacteal veſſels of a turtle,
" or ſea-tortoiſe, with quickſilver, after
" injecting the artery and vein with wax,
" and have ſhewn this inſtance of the
" veſſels in the oviparous animals every
" year in my college, and had a draw-
" ing made of it two years ago by Dr.
" Palmer, a copy of which I have ſent
" incloſed, engraved by Donaldſon.

" I likewise, eight years ago, men-
" tioned thoſe veſſels in Fowls and Fiſhes,
" which I had ſeen, but not injected."

Here then is an aſſertion about the veſſels which I had diſcovered, that is far from being equivocal. For here he affirms, that he really had ſeen them eight years ago, nay, that he had even mentioned them to others. This letter too was ſent immediately after he heard that I had laid before the Society an account of thoſe veſſels in Birds and Fiſh *. It could not therefore be meant merely to inform the Society that, now ſeeing Mr. H. had diſcovered the Lacteals and Lymphatics in Birds and Fiſh, he likewiſe had the pleaſure of ſhewing them that he (Dr. Monro) had diſcovered them in the turtle. This, I ſay, could not be his meaning; for if it was, why did he ſend his letter ſo precipitately? Why did he not ſend a deſcription of thoſe veſſels in the turtle, in order to make his letter worthy their notice? And why did he ſay he had ſeen them in Birds and Fiſh? The Society, he knew, wanted not his teſtimony to prove that Birds and Fiſh had them. What then could he mean by it, but to claim the diſcovery?

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* As he acknowledges, State of Facts, p. 4.

As there could be no doubt that Profeſſor Monro meant this letter as a claim to theſe diſcoveries; neither had I any doubt but I ſhould, for the reaſons abovementioned, prove that he had no right to them. In order therefore to prevent the prejudices that might ariſe againſt my papers, from his being believed to have anticipated me in theſe diſcoveries, I wrote a letter to one of the ſecretaries of the Royal Society, in which I firſt ſhewed, that I had ſeen the Lacteals of the turtle about a year before him, and then, when I came to ſpeak of thoſe veſſels in Birds and Fiſh, againſt the probability of Dr. Monro's having anticipated me in theſe diſcoveries, I made uſe of the following arguments.

1*ſt*, HIS not having, by his own confeſſion †, injected them, which he certainly would have done, in order to complete the diſcovery. To which I obſerved he had the ſtrongeſt motive, both from his knowing the importance of the ſubject, and from his having unfortunately declared, in the 57th page of his Anatomical and Phyſiological Obſervations, printed at Edinburgh, 1753, "that, "after a conſiderable number of expe-"riments which he had made, he was "convinced, that neither Birds, Fiſhes, "nor oviparous animals in general had "either Lacteals or Lymphatic Veſſels." After which declaration, I conceived it improbable he ſhould patiently wait eight years without injecting them, eſpecially as I had found it an eaſy matter to inject them, when once they were diſcovered. And I added, the probability was, that if he had *ſeen* thoſe veſſels, he would have haſtened to inject them, and to complete the diſcovery, were it only to prevent another perſon's doing it, and thereby acquiring the reputation of having done what he himſelf had *in vain* attempted by ſuch a conſiderable number of experiments as *were ſufficient to convince him*, that ſuch veſſels exiſted not in thoſe animals.

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† In his claim; ſee above, p. 172.

2*dly*, I SAID, his claim to the diſcovery of thoſe veſſels, by affirming he had ſeen them eight years ago, was contradicted by public declarations made after that time; for he had, ſince, acknowledged in his lectures, *that he had ſought for them in vain by a variety of experiments.* And even ſo late as within theſe two years †, he declared likewiſe in his public lectures, "that the Lymphatic Syſ-"tem was ſuppoſed to take place only "in men and viviparous animals, and "by analogy in thoſe fiſhes placed by "Linnæus amongſt the *mammalia*, and "how far was their juſt extent (he ſaid) "was not certain, but that he had found "them in ſome amphibious animals, as "in the turtle." Theſe declarations, I obſerved, were inconſiſtent with his claim to the diſcovery.

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† My letter being dated Jan. 10, 1769.

Besides uſing theſe arguments, I promiſed the Society I would hereafter produce unqueſtionable proofs of the invalidity of his claim, having by this time found, that the Doctor, fortunately for me, had expreſsly acknowledged in his lectures, *that he had ſought for them in vain*, almoſt every year ſince the time that he now pretends to have ſeen them.

Dr. Monro being informed of theſe proceedings, ſent me his letter, dated June the 8th, which he has ſince printed in his *State of Facts*. But that letter appeared ſo confuſed, that I knew not what to make of it. Sometimes I thought it was meant to prove that he had diſcovered thoſe veſſels, agreeably to his aſſertion read before the Royal Society: but this I ſoon after ſuſpected could not be the caſe, becauſe, after relating all his facts and experiments, he concludes, *not* that he had diſcovered them, *but only* "that he had ſeen what he ſtrongly "*ſuſpected* to be lacteals in thoſe animals" (*viz.* Birds *)—And, "that "(from preceding experiments) he was "*perſuaded* that Birds were provided "with lacteal veſſels, and confirmed in "this *opinion*, by having injected them "in one of the ſame oviparous claſs, "the turtle †."——Or, in other words, Dr. Monro claimed a diſcovery, by telling the Royal Society that he had *ſeen* thoſe veſſels in Birds eight years ago, which he now proves, by ſhewing he had only *ſuſpicions* about them, and an *opinion* that Birds had them, becauſe Turtles had them.

At other times, I thought that poſſibly, after finding what his pupils teſtified, he might now be convinced he had imprudently claimed thoſe diſcoveries, and might intend this as a ſort of an acknowledgment (tho' an aukward one) of my being the firſt who had ſeen thoſe veſſels. But the vindictive ſtile of his letter convinced me it was not meant as an apology †, as likewiſe did the ſtile of a ſhort note written on the cover of that letter, of which note the following is a copy.

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* State of Facts, p. 21.

† Ibid. p. 23.

To Mr. Hewson, &c.

SIR,

When you have read the incloſed, you are very welcome to write ſuch remarks on it, as to you, or to your friend Dr. H——r, or to any of his friends, ſuch as Dr. ——, &c. may ſeem proper; only when you have done, I think you ought to ſhew it to all thoſe ſocieties, phyſicians, and ſtudents to whom you have made free with my name; or, if this taſk ſhould not ſuit your diſpoſition, or be irkſome to you, after the great fatigue you have taken about me already, pleaſe to let me know this, and I ſhall take that trouble on myſelf.

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† As for inſtance, where he talks "of (his) "making all the allowance I require for my natural, "or (ſays he) I ſhould rather call it, unnatural "imbecility of memory." This paſſage is altered in his *State of Facts*, p. 22.

I am, Sir, &c.

(Signed) ALEX. MONRO.

Edinburgh, June 24,
1769.

THIS ſeemed clearly not to be the ſtile of one who was ſenſible of his error, and was apologizing for it; and convinced me, that Profeſſor Monro intended that letter as a proof of his right to thoſe diſcoveries. However, not to be poſitive that I had hit upon his meaning, I determined, before I laid any thing before the pubic, to aſk an explanation of that letter. For this purpoſe I wrote to him on the 15th of July, and deſired him to tell me "whether he meant it as a "proof of his right to thoſe diſco-"veries."——or "whether he meant by "it to give up to me the right to them." And as I had found him in that letter wandering from the ſubject, and inſtead of concluding that he *really* had ſeen thoſe veſſels, concluding *only*, that he had ſeen what he *ſuſpected* to be the Lacteals in Birds——And again, that he was *perſuaded* Birds were provided with thoſe veſſels—but no where ſaying that he had ſeen what he *knew* or *could prove* to be their Lacteals, which alone could give him a right to the diſcovery: I therefore told him, "that to avoid for "the future all wandering from the "ſubject, I ſhould ſtate the diſpute as "it appeared to me;" and then I ſaid, that "it was he who began it, for, on

" hearing that I had diſcovered the " Lymphatic Syſtem in the three claſſes " of oviparous animals, he had ſent a " letter, which was read before the " Royal Society, and was to be ſhewn " to every body. In this letter he " aſſerted, that he had diſcovered the " Lacteals in a Turtle about four years " ago, and in Birds and Fiſh eight years " ago; and that he even mentioned " theſe diſcoveries to others." Theſe aſſertions (I added) were conſtrued a claim to the diſcoveries I had made. With this letter I likewiſe ſent him a copy of mine, which had been read before the Royal Society. By theſe means I thought I ſhould either keep him to the ſubject in queſtion, or, if he ſhould again wander, the reader would be convinced it was not my fault, but his own, that he *now* knew not what he had *then* aſſerted.

THIS letter, however, had no effect. I therefore wrote to him again, hoping he might now be convinced that his claim was ill-founded, and might therefore be induced to retract it, inſtead of obliging me to prove to the world its invalidity. The following is a copy of the letter which I ſent him on that occaſion:

SIR,

IT is now above ſix weeks ſince I wrote to you, deſiring an explanation of your letter of the 8th of June. As you have not given me that explanation, I have now taken up the pen to inform you, that agreeably to your own deſire, and in order to juſtify my conduct towards you, I am commenting upon that letter which you ſent me. My comment would be more to the purpoſe, were I always ſure I underſtood you, but if that ſatisfaction ſhould ſtill be denied me, I muſt proceed as well as I can, and I muſt ſay, that if I ſhould miſtake your meaning, it will not be wilfully, ſince you might, by an anſwer, have cleared up all ambiguity. I cannot help regretting, that this diſpute ſhould ſubſiſt between us, both on my own account, as I think it hard to have the trouble of proving my right to diſcoveries which are certainly my own, particularly as it takes up that time which I hoped to employ to a better purpoſe; and I likewiſe regret it on yours, ſince, in order to maintain my right, I ſhall be under the neceſſity of producing ſome facts and teſtimonies, which, in my opinion, cannot but lead to concluſions very unfavourable to your reputation. And as I ſhould be ſorry that one of my firſt attempts to lay the foundation of my own character, ſhould be attended with circumſtances which may hurt yours, and really wiſh to avoid it; I therefore ſtill hope that this diſpute may be ſettled in a more eaſy manner. You muſt, I think be now convinced, that in claiming theſe diſcoveries you have injured me, and cannot be at a loſs to know what might be expected from you on ſuch an occaſion. But if inſtead of doing me that juſtice which might be expected from a man of candour, you treat this letter likewiſe with ſilence, then juſtice to myſelf requires that I ſhould no longer delay producing ſuch proofs as I poſſeſs of your having no right to theſe diſcoveries, and ſhewing them to the very reſpectable Society, to which I have promiſed them; or to ſuch *phyſicians, ſtudents, &c.* as may have heard of your claim; without regretting much that thoſe meaſures which I take to maintain my right, may perhaps affect ſenſibly the character of a man, who having firſt injured me and afterwards had his error pointed out to him, was incapable of candidly acknowledging it.

I am, Sir, &c.

(Dated)
Sept. 9, 1769.

In anſwer to this letter, he ſent me one dated Sept. 30, in which, inſtead of anſwering my queſtions, he evades them, concludes as vaguely as in his former; and when he ſpeaks of his aſſertion read before the Royal Society, alters its ſenſe, qualifying the alteration with "*to the* "*beſt of his recollection*" denies he was miſtaken in claiming theſe diſcoveries. And, what is ſtill more remarkable, accuſes me of having made concluſions injurious to him, "*by arguments, weak,* "*inconcluſive, not real, but feigned.*"

It was evident, from ſuch a letter, that he would not embrace the opportunity I offered him, and avoid a diſpute, by acknowledging his miſtake, and retracting his claim. I therefore no longer heſitated to print the proofs I had collected of his not having anticipated me; and though I had once intended to make ſome remarks on his letter of the 8th of June, as is mentioned above, yet I afterwards determined to omit theſe, ſince the teſtimonies of his pupils alone ſufficiently proved that he had no right to thoſe diſcoveries. By theſe means I reduced the publication to half a ſheet of paper: in which I firſt gave an account of his claim made, by ſaying "*he had ſeen thoſe* "*veſſels* EIGHT *years ago*;" then I mentioned, as arguments againſt its *validity*, that I had myſelf heard him ſince that time declare, "*he could not find thoſe* "*veſſels*," and that, beſides, I had a note taken at his lectures by a gentleman within two years of his making it, which contained a ſimilar declaration *, and afterwards

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* Dr. Monro has miſinterpreted this paſſage. He ſuppoſes I meant that this note was taken two years before 1762, whereas I meant two years before 1768, the time when he claimed theſe diſcoveries, and when I wrote my letter to the ſecretary of the Royal Society. The note itſelf is printed above, page 176.

Dr. Monro has taken notice of another inaccuracy, that is, where I had ſaid, "He aſſerted that "he afterwards I ſaid that I had written to ſuch gentlemen as I knew had, as well as myſelf, attended his lectures within theſe eight years, deſiring them to conſult their notes, and to let me know what Dr. Monro had ſaid as to the exiſtence, or non-exiſtence, of the lacteals and lymphatics in theſe animals; without mentioning the diſpute between us, or any opinion I had formed, that they might be unprejudiced to either party. And that ſuch of theſe gentlemen as had taken notes ſent me excerpts from them, which, as I had ſuſpected, agreed with what I had myſelf heard the Profeſſor ſay upon that ſubject.

That Dr. Haygarth, phyſician at Cheſter, had ſent me the following paſ-

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"he had anticipated me in theſe diſcoveries;" inſtead of ſaying "that he claimed them by aſſerting "he had injected, &c." The former Dr. Monro ſeems to allow to be what he meant, but not *exactly* what he ſaid. It was therefore a ſmall inaccuracy. But his claim is now printed *verbatim*. See above, p. 172.

ſage from the notes which he had taken in 1764.

"Fowls, and ſome Fiſh (ſays Dr. "Monro) have not lacteal veſſels that "we can ſee; they have no con"globate glands in the meſentery; per"haps they (the lacteals) don't run into "each other, but into red veins, and "hence never are ſo large as to become "viſible."

"This note," adds Dr. Haygarth, "was taken in 1764, and if Dr. Monro "had changed his ſentiments on this "ſubject in the year 1765, I ſhould cer"tainly have taken notice of ſo remark"able a circumſtance."

That, from Mr. Orred, ſurgeon at Cheſter, who attended Dr. Monro's lectures during the winter 1765-6, I had learnt, that Dr. Monro, when he ſpoke of the anatomy of a cock, declared: "he

" never ſaw, or obſerved any *glandulæ* " *vagæ*, or lacteals, but had ſeen lym- " phatics in the neck, ending in the " jugular *."

That, from ſome notes, ſaid to be copied from thoſe taken by Dr. Taylor of Reading, in the winter 1765-6, I had procured the following excerpt; and Dr. Taylor, on being requeſted to conſult his own copy, had acknowledged it was a juſt one.

" The lymphatic ſyſtem (ſays Dr. " Monro) is ſaid to take place only in " men, and viviparous animals, and " from analogy in thoſe fiſhes placed by " Linnæus, under the claſs of *Mam-*

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* It may be neceſſary to mention here, that the diſpute between Dr. Monro and me is, *who firſt diſcovered the lacteals of birds?* for as to the *lymphatics* in their necks, (mentioned in this gentleman's note,) theſe we both allow, were diſcovered by Mr. John Hunter about ten years ago.

" *malia* *: how far is their juſt extent " is not certain, but we have found " them in ſome amphibious animals, as " in the turtle †.

" It is ſaid that this ſyſtem is wanting in oviparous animals; but this is " not univerſally true; for we mentioned, that we found them in a " turtle, and they would probably be " found in other orders and *genera*, if " properly examined. But admitting " that they are not demonſtrable there,

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[*] In the excerpt it is *amphibia*; but it is evident from the ſenſe, and from comparing it with the other notes, that it ſhould be *mammalia*.

[†] As to the *lacteals* of the turtle, there is no doubt but that Profeſſor Monro and myſelf have both diſcovered them. He, in the ſummer 1765; I before that time, viz. in the autumn 1763; when I took a ſhort deſcription of thoſe veſſels, which is publiſhed with my paper on the lymphatic ſyſtem in birds, in the 58th volume of the Philoſophical Tranſactions.

“ it doth not follow that they are want-
“ ing; for, perhaps, they may run
“ only a little way, and terminate in red
“ veins.”

That Dr. Maddocks, phyſician to the London Hoſpital, had favoured me with the following excerpt from notes which he took at Dr. Monro's lectures, in the winter 1765-6.

“ Lymphatics are found in vivi-
“ parous animals, and therefore, I pre-
“ ſume, in the whale, which is of this
“ kind. They are not to be found in
“ oviparous ones, fiſhes, nor the *am-*
“ *phibia:* this is the common doctrine.
“ *I will not ſay how far they may be*
“ *found in ſome birds*, but I have found
“ them in ſome of the amphibious ani-
“ mals, as in the turtle, running along
“ the root of the meſentery.”

THAT Mr. Hull, ſurgeon at Stevenage, had ſent me the following excerpt from his notes, taken about four years ago.

“ I NEVER could, to this day, (ſays “ Dr. Monro) find a ſingle branch of a “ lacteal in the abdomen of fowls, nor “ any lacteals, or glands of the conglobate kind in the meſentery, notwithſtanding I have made experiments “ with that view very often. I kept “ fowls twenty-four hours without food, “ then fed them with bread ſoaked in “ milk, and tinged it by turns with “ blue, madder, and ſaffron, and afterwards opened them at ſeveral different “ times, in order to diſcover the lacteals, “ but all without ſucceſs. Yet, perhaps the lacteals may be in fowls, “ though not demonſtrable.” This, adds Mr. Hull, I will anſwer for being *verbatim*, or nearly ſo, as Dr. Monro delivered it in the anatomical hall, at

Edinburgh, on the 13th of February, 1765 *.

These paſſages, I added, were ſufficient to ſhew how little right Dr. Monro had to theſe diſcoveries. Beſides, I ſaid it was a ſtrong argument againſt him, that in the letter I had received (which he has printed in his State of Facts, p. 8.) he could not, after relating all his experiments and obſervations, conclude he had *really* ſeen thoſe veſſels as he had told the Royal Society; but in one place he ſays, " that, from the preceding " experiments, &c. it is evident that he " had ſeen what he *ſuſpected* to be the " lacteals in birds." And in another, " that he was himſelf *perſuaded* that

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* If the reader will take the trouble of comparing this note with Dr. Monro's own account of his experiments, (State of Facts, p. 12.) he will be convinced how accurately this gentleman muſt have taken notes.

“ birds were provided with lacteal veſ-
“ ſels, and confirmed in this *opinion*, by
“ having now injected them in one of the
“ ſame oviparous claſs, the turtle †.”

Such concluſions appear merely evaſive, and never can be conſidered as proofs of his having diſcovered thoſe veſſels before I did, agreeably to his aſſertion read before the Royal Society, and ſince repeated in his State of Facts.

The half-ſheet of paper, containing theſe arguments and teſtimonies againſt Dr. Monro, was printed Dec. 1. 1769, and was given to ſuch gentlemen of my acquaintance as had heard of his claim, and a copy of it was ſent to the Doctor. Upon receiving which, he publiſhed his State of Facts; but what is ſingular, he

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† This argument was repeated in a note, to prevent Dr. Monro's writing; as if the diſpute between us was, *who firſt had ſuſpicions about thoſe veſſels*, inſtead of *who firſt diſcovered them.*

has

has attempted his juſtification without taking proper notice of theſe teſtimonies againſt him; as if he could be juſtified whilſt they remain unanſwered. And in this State of Facts, in ſpite of thoſe teſtimonies, he repeats to us, "that long "before 1762, he obſerved blueiſh veſ"ſels in the meſentery (of birds) which "he *judged* to be lacteals, and *had men"tioned as ſuch* in his lectures *." And again, "that about the years 1759-60, "he had ſeen collapſed blueiſh veſſels, "which he *concluded* lacteals, &c." †. What ſhall we ſay of this?

NAY, Dr. Monro has, upon this occaſion, even ventured another aſſertion, "viz. "that the notes of his pupils taken "for three years before 1762, will be "found to prove, that he then taught "the direct contrary" of what I have brought theſe teſtimonies to prove he has ſince taught ‡. Now, ſurely this is very improbable; and Dr. Monro ſhould have adduced ſome teſtimonies to prove it. But ſuppoſing it were true, it would lead to a concluſion unfavourable to him. It would ſhew, that he muſt have miſled either the one ſet of gentlemen or the other;—for he ſays, he told the firſt he had ſeen the lacteals—the laſt prove he has ſince taught them that he *never could ſee* thoſe veſſels.

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* State of Facts, p. 4.

† Ibid. p. 27.

The reader, I fancy, by this time thinks with me, that Profeſſor Monro's claim deſerves no more of our attention. But, as he has printed ſome excerpts from his own book of notes, with the parade of having them authenticated, as if they contained the diſcovery, notwithſtanding the above-mentioned proofs of his having acknowledged repeatedly ſince he wrote them, that he never could find thoſe veſſels, I ſhall next, therefore, make ſome remarks upon his notes.

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‡ State of Facts, p. 26, in the note.

To begin with thoſe relating to the turtle. He diſcovered its lacteals in the ſummer 1765. I had ſeen them before that time, viz. in the autumn 1763. Beſides, I have ſince injected and traced out the whole ſyſtem *; he does not even pretend to have done ſo: it is, therefore, not difficult to determine, who was the firſt diſcoverer, and who has carried the diſcovery fartheſt.

Next, as to the lacteals in Fiſh. To prove that he had found thoſe veſſels eight years ago, he tells us, that in a note taken from the diſſection of a ſkate on April 24, 1760, he has ſaid, "He "had diſcovered a whole ſyſtem of "lacteals and lymphatic veſſels running "towards the heart, on the left of, and

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* See Philoſoph. Tranſact. vol. lix.

"above the *vena portarum*, and from "theſe the auricle of the heart was "blown up. They are proportionally "larger, but have fewer valves than in "man †" Now, I will take upon me to ſay, there is nothing in this note which proves whether he had inflated a lacteal or a vein. For what he ſays of the ſituation of the veſſels, and of his blowing up the heart, is equivocal: the only part of the note which appears to characteriſe the lacteals, is in reality a miſtake; that is, where he ſays *they have valves*. But the lacteals on the meſentery of a ſkate have no valves, and injections paſs readily from the large to the ſmaller branches. And what is even more to the purpoſe, although it appears, from his calling what he ſaw *lacteals* and *lymphatics*, that he had at that time ſome ſuſpicions about them. Yet I am perſuaded he has ſince changed his opinion; and this I think is evident, even from the manner in which he ſpeaks of his experiments made the year after. For, ſays he, "I have diſſected this year (1761, "in ſummer) eight ſkates, and about a "like number of cods and codlings, but "without being able to obſerve by diſ-"ſection, or to inflate any like to lacteal "or lymphatic *glands*—I find indeed "(he adds), that blowing backwards in "the meſeraic veins, the inteſtines and "the cellular ſubſtance between their "coats are inflated but this is no direct "proof of branches of red veins ab-"ſorbing, as theſe veins may be burſt, "or the air may have firſt entered the "arteries *." Now, this ſurely is not the language of a man who had ſeen the lacteals, but of one that was ſeeking for them. Had he found them, he certainly would have mentioned it in this note, but he avoids the ſubject entirely, and only ſays he could not find the *glands*, thereby leaving us to ſuppoſe that theſe diſſections were made for the *glands only*, after having diſcovered the *veſſels:* which is highly improbable, ſince, by his own confeſſion †, he did not inject the veſſels, which he knows well enough is the beſt way of determining whether the glands exiſt or not; and *one* experiment in this way would have been more ſatisfactory than his *eight*, or than eight hundred made by diſſection only ‡. Add to this, he would not, I think, if he had now ſeen the lacteals, have taken up his time with trying whether the red veins did the office of abſorption for them, as he ſeems to have done by blowing into theſe veins. Nay, I will go farther, and will take upon me to ſay, that it is probable he was in theſe laſt diſſections convinced he had been miſtaken in what he took the year before for lacteals and lymphatics. This I think evident, both from the notes abovementioned, and from his manner of treating the ſubject ſince that time. For, if he thought he had ſeen thoſe veſſels, he would doubtleſs have uſed this diſcovery as an argument againſt abſorption by the common veins, as he has ſince uſed that in the turtle. But it appears, from the notes of his pupils †, and even

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† See State of Facts, p. 12.

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* State of Facts, p. 12.

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† See his claim above, p. 172.

‡ If the reader ſhould happen not to be well-acquainted with this part of anatomy, he may not ſee all the force of this argument, which will be ſatisfactory to anatomiſts; for it is a fact admitted amongſt them, that the meſenteric glands are placed only in the courſe of the lacteals, ſo that the lacteals muſt paſs through theſe glands in their way to the heart. The readieſt method therefore of diſcovering the glands, after having ſeen the veſſels, is by injecting thoſe veſſels; for the injection, in its way to the heart, muſt diſtend the glands, and make even the ſmalleſt of them viſible. The veſſels ſeen by the Doctor ſeem to have been very large; can it be ſuppoſed then, if he had been convinced they were lacteals, that he would not have injected them,

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them, and thus have determined whether there were glands or not, by one experiment, inſtead of tediouſly diſſecting ſixteen Fiſh ?

† See his pupils notes above, p. 189, &c.

ſrom his own account of thoſe arguments †, that he has not done ſo. And again, had he thought he had diſcovered thoſe veſſels, he would not have acknowledged in his lectures ſince that time, that they were not yet known to exiſt ‡. He has therefore aggravated the impropriety of his conduct in claiming theſe diſcoveries, by the diſingenuity of ſending ſuch notes as proofs of his claim.

And laſtly, as to the lacteals in *birds*, he tells us, "that, in 1758, he re-"marked a veſſel making an arch on "the meſentery of a cock, which at "firſt he believed to be a trunk receiving "the lacteals, but not being able to in-"ject it on trial, he conjectured to be "rather a nerve." And afterwards, in April 1759, "he obſerved in a cock

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† See State of Facts, p. 16.

‡ See the notes of his pupils above, p. 189.

“ what *looked like* lacteal veſſels col-
“ lapſed, of a blueiſh colour, which
“ ſeemed to terminate at the back-bone,
“ &c.—Theſe he ſhewed to the ſtu-
“ dents.” And again, after relating the manner of making his experiments upon no leſs than twelve cocks *, he tells us, “ that in 1761 he obſerved, in
“ the interſtices of the great arches of the
“ red meſenteric veſſels, a pellucid net-
“ work, ſome part of which ſeems to be
“ compoſed of branches ſent from a
“ large nerve, running parallel with the
“ inteſtines, and nearer to them than
“ where the trunk of the meſenteric
“ artery ſends off its large branches;
“ but although (ſays he) *I ſuſpect*
“ *ſtrongly* there are here too numerous
“ lacteals, and I even obſerve very ſmall
“ knots, which I take to be analogous

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* The experiments were made by feeding theſe birds with oatmeal and madder, oatmeal and rhubarb, &c. See State of Facts, p. 12.

“ to our meſenteric glands, yet I have “ not obſerved the above-mentioned “ kinds of food to make any odds in their “ appearance *, &c.” And again, after a variety of other experiments, he ſays, “ he could not obſerve more than above-“ deſcribed.” Now, what is there in theſe notes that can entitle him to the diſcovery of the lacteals in birds ?—Can his ſeeing a blue plexus on the meſentery, which at firſt indeed he ſuſpected to be lymphatic, but afterwards to be nervous, and a part of which, he acknowledges, was in his laſt experiments found to be made of nerves, entitle him to it? or can his diſcovery of theſe ſmall knots, which he takes to be analogous to our glands, entitle him to it? Certainly not. Birds have no lymphatic glands on their meſenteries, as I have ſhewn †. Is it not therefore plain, from theſe notes themſelves,

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* State of Facts, p. 12.

† Philoſoph. Tranſact. vol. lviii. art. 34.

themſelves, that he had not diſcovered the lacteals in birds? Has he not repeatedly ſince that time acknowledged this in his lectures*? What ſhall we ſay then to his aſſerting that he had ſeen them eight years ago, and his laying before a reſpectable Society, and deſiring his brother to propagate ſuch an aſſertion? Or what ſhall we ſay to his perſiſting in it, or above all to his telling us, in his laſt publication (p. 26.) "that "in theſe notes the reader will find the "appearance of theſe veſſels after death "really deſcribed†?"

After theſe notes follow ſome others, to prove that he had *argued* in favour of the probability of the exiſtence of thoſe veſſels in Birds and Fiſh; and a concluſion that he had *ſuppoſed* frogs might have them; and his *ſuſpicions* that Birds might have them—And his *perſuaſions* that they muſt have them *(not becauſe he had ſeen them, but)* becauſe turtles had them. Which are nothing to the purpoſe, and ought never to have induced him to claim the diſcovery, or to ſay he (actually) had ſeen them. I cannot therefore think it worth while to take any farther notice of theſe concluſions.

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* See the notes of his ſtudents above, p. 189.

† Let me beg of the reader again to examine theſe notes, and then judge of the propriety of Dr. Monro's affirming they really contain a deſcription of thoſe veſſels, when he has himſelf put it in the power of the reader to obſerve the contrary.

IT is indeed remarkable, that Dr. Monro could perſuade himſelf he had any original merit *even* in entertaining ſuch *ſuſpicions* and *opinions*. More than one writer had ſuſpected thoſe animals had them, and that they themſelves had ſeen ſomething like them; for a proof of which the reader need look no farther than Dr. Haller's *Elem. Phyſ.* *. But, as thoſe writers had given no proofs of their having diſcovered them, their *ſuſpicions* and *opinions* paſt for nothing.

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* Lib. ii. Sect. 3. & Lib. xxiv. Sect. 2.

Professor Monro, not ſatisfied with claiming theſe diſcoveries, has even gone farther; he has intimated, in ſome parts of his book, that I might have learnt them, or a part of them, from him. As in page 4, where he ſpeaks of my "giving an account of theſe veſſels entirely as my own diſcovery," this in page 6. he calls "broaching another "ſubject with him;" and complains of me "for paſſing in ſilence what I might "have heard him obſerve concerning it "when I attended his lectures."—How Profeſſor Monro could pretend that I had learnt any thing from him on this ſubject, that ought not *for his ſake* to be paſſed in ſilence, is aſtoniſhing. What could I learn from one who has repeatedly ſince that time acknowledged *he never ſaw* theſe veſſels; *that they might be too ſhort to become viſible*; and who, at the time I attended his lectures, ſaid, he could not find them, as I have already declared. But, as my teſtimony will have more weight with the reader, when corroborated with that of a gentleman unconcerned in the diſpute, I ſhall next add a copy of ſome notes taken by Dr. Morgan, now profeſſor of medicine in Philadelphia, who attended Dr. Monro's lectures at the ſame time with myſelf, and who, at my requeſt, ſent me the following excerpt, taken at his lecture upon the queſtion, Whether the common veins abſorb or not?

" MOST authors (ſays Dr. Monro) " concurring in opinion, that fowls " were deſtitute of lymphatics, and not " being able to diſcover them myſelf, I " was led to be of their opinion. I have " already obſerved, that where conglo- " bate glands are found, there are " lymphatics, and the converſe of this

"propoſition, namely, where there is
"no conglobate gland, there are no
"lymphatics. And there being no con-
"globate glands to be ſeen in the
"meſentery of fowls, nor in fiſhes, I
"judged theſe animals to be deſtitute of
"lymphatics; but Mr. John Hunter
"having diſcovered conglobate glands
"in the neck of a ſwan, put me on fur-
"ther ſearch, and I then found them
"plainly in common fowls, *but never*
"*could find any lacteals* in their meſen-
"tery, though experiments were tried
"by means of coloured tinctures of va-
"rious ſorts, as of rhubarb, &c."

FROM this excerpt it is evident, that Profeſſor Monro, when I attended his lectures, taught, as he has ſince done, that what he knew of the lymphatics he learned from Mr. Hunter, and as to the lacteals *he could not find them*; and this was in the ſpring, 1762, the very year after the time when, according to his letter read before the Royal Society, he ſhould have ſeen theſe veſſels, and mentioned them in his lectures: and finally, to complete the whole, he now complains of me for paſſing in ſilence what I might then have heard him obſerve concerning them.

Thus have I endeavoured to obviate the arguments in Dr. Monro's publication, and the reader muſt now, I think, ſee clearly, not only the impropriety of the Doctor's aſſerting his right to theſe diſcoveries, but the ſtill greater impropriety of his perſiſting in that aſſertion.

Besides claiming theſe diſcoveries, Dr. Monro has, in his letters on the ſubject, treated me in a manner which I cannot paſs unnoticed—Thus, he firſt gives the name of miſinterpretation to my concluding from the notes of his

pupils,

pupils, that he had not ſeen "what "he believed" the lacteals, and then adds:

"Should we even ſuppoſe the above "miſinterpretation venial, what muſt "the reader think, when he is told, "you was informed that a gentleman, "who had attended my lectures two "years at leaſt before I injected the "lacteals of a turtle, that is, nearly "about the time you did, declared he "heard me then ſpeak of having *ſeen* "*the lacteals in fowls*; and yet that "you continued to vent this injurious "ſuppoſition? That is, you muſt have "ſunk this material information, ſince "it overturned the whole purport of "your ſtory *."

Now, here is an accuſation, which, were it true, would fall heavy upon me.

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* See his State of Facts, p. 23.

But the caſe is this; I had indeed heard that a gentleman, who attended Profeſſor Monro's lectures about the time I did, had declared he then underſtood the Profeſſor had ſeen the *lymphatics* in Birds. And Dr. Donald Monro, when I ſaw him at St. George's Hoſpital, aſked me, if I had not heard that this gentleman (mentioning his name, viz. Dr. James Blair, then in London, now in Virginia) had ſaid, that the Profeſſor had then mentioned his having ſeen the *lacteals* in Birds. I anſwered Dr. Donald, that I had heard ſomething of the matter, but could conclude nothing from it (or to that effect). The reaſon was this; I knew from the teſtimony of my own memory, that the Profeſſor had then acknowledged the contrary of his ever having ſeen the lacteals †. I knew the ſame from the teſtimony of gentlemen who had attended his lectures ſince. I therefore concluded that this gentleman had confounded his ſaying he had ſeen the *lymphatics*, with his ſaying he had ſeen the *lacteals*, which I thought might eaſily happen, as I never knew him take any notes. And upon receiving the Profeſſor's letter, I wrote to Dr. Blair, and in his anſwer he acknowledged, "that although he had, indeed, for "ſeveral years, been under a general "perſuaſion that Dr. Monro had ſeen "the *lacteals* or *lymphatics* in fowls, "yet he had no note on the ſubject, and "a very confuſed remembrance of what "he had heard."

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* Dr. Morgan's note proves he did ſo, ſee above, page 209.

SIMILAR to this accuſation is the greater part of a letter which I received from Dr. Monro, in anſwer to two of mine. This letter is dated Sept. 30, 1769. The Doctor has not printed it, but I beg leave to take a little notice of it.

He begins it by altering the ſenſe of his aſſertion read before the Royal Society, by the introducing the word *believed*, making it rather a doubtful than a poſitive aſſertion. He has done the ſame in the beginning of his State of Facts, qualifying the alteration, by adding, "*to the beſt of his recollection*, "*and that he had not kept a copy of his* "*letter, not ſuppoſing it material to do* "*ſo*[*]." But ſurely this was not ſufficiently qualifying it. If he did not know exactly what he had then aſſerted, why, before he defended it, did he not aſk a copy from his brother, who, moſt probably, would keep it, *in order to ſhew it to every body*; or ſollicit that favour from the ſecretaries of the Royal Society where it was read, who, he might be ſure, had preſerved it, as they do every paper that is laid before the Society. And again, if he was not ſure of its contents, how could he now venture, in his State of Facts, *poſitively* to inſiſt, in oppoſition to what I had declared, "that his firſt and laſt aſſertions "were exactly the ſame *." This at leaſt was inexcuſable.

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[*] See State of Facts, p. 5.

Next, he repeats his vague inferences as in his letter of the 8th of June, "that "he had ſeen what he *ſuſpected* to be "thoſe veſſels, &c." and afterwards, when he comes to ſpeak of the concluſions concerning his claim, which I made in my letter read before the Royal Society, he ſays, "That he was almoſt "aſhamed, on my account, to add a "plain corollary, that I muſt or might "have been conſcious, that the injurious "concluſion with reſpect to him, which "I was labouring to impreſs on the "members of a reſpectable Society, was "drawn from arguments that were "weak, inconcluſive, not real, but "feigned."

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* State of Facts, p. 26, in the note.

"feigned *." Afterwards he tells me, "that he is glad, *on my account as well* "*as his own*, that I am at laſt really "aſhamed of my letter." And he then finiſhes with the following paſſage: "Another unhappy miſtake of yours "(ſays he) is, that you ſhould not have "known, or rather perhaps misfortune "of yours, ſince you don't ſeem to have "known ſo much, that you ſhould not "have been told, that your preſuming "to draw the above concluſion concerning "any perſon who had the ſmalleſt "pretence to character, without producing "proof and abſolute certainty of "its being true, was what you never "could be able to juſtify to any *gentleman*."

Now, when it is conſidered that Dr. Monro obliged me to act in the manner I have done, in order to ſecure my right, do not theſe paſſages appear very extraordinary? —— But the reader, I believe, will excuſe my not dwelling upon them. I ſhall therefore only add, that the *proofs* on which my *concluſions* were founded, being now laid before the public, to their judgment I willingly ſubmit them, and that, with reſpect to Dr. Monro, I have nothing more to ſay, than that I hope *for his ſake as well as my own*, to ſee no more of his *claims*, his *aſſertions*, and his *concluſions*.

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* The concluſions alluded to in theſe paſſages are printed above, p. 175, and 176.

THE END.

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